DR. THEODORE T. JONES

APPLIED ANATOMY

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DESIGNED FOR THE USE OF OSTEOPATHIC STUDENTS AND PRACTITIONERS AS AN AID IN THE ANATOMICAL EXPLANATION OF DISEASE FROM AN OSTEOPATHIC VIEWPOINT.

—BY—

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Illustrated With 175 Engravings, of Which Several are in Color, and Many Halftones from Photos.

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PREFACE

Realizing the close relation existing between anatomy and osteopathic therapeutics, that the science is built on anatomical and physiological knowledge, I in 1901 outlined a course in a subject that I chose to call, Applied Anatomy. This book is the outgrowth of that attempt to anatomically explain the signs, cause and treatment of disease.

The object of this work is to place osteopathy on a scientific basis by offering anatomical and physiological proof that our etiology of disease is correct; to demonstrate that disturbance of function is, as a rule, due to structural changes, and to point out the significance of anatomical changes; and to furnish the practitioner a ready reference for the explaining of lesions and their effects. Anatomical details have been avoided unless of importance in the explanation of the subject.

I am fully aware that many will differ with me in some of the statements made, also that errors unintentional and unavoidable, have crept into the text. Having no precedent, this being a practically new work along its line, it was found hard to avoid repetition and present the subject in an interesting and at the same time, an instructive and correct way.

In the arrangement of it I have followed my notes used in the presentation of the subject to my classes. The articulations of the body are first studied, this being followed by a consideration of the regions of the body, the nervous system and the viscera.

The scope of the work is not confined entirely to anatomy, but use is made of physiology, pathology and physical diagnosis in the interpretation of the signs of lesions and disease. In fact, it is almost as much of a work on applied physiology as it is of applied anatomy.

The illustrations have been taken from various sources. Many are from drawings of dissections, some adapted from the standard works, some reproduced, and others from photographs of cases seen and treated by the writer. Due credit is given when the illustration is not original.

They are designed to elucidate the text and on this account have been arranged so that they come at or near the part of the text that they are intended to illustrate.

In the preparation of the work, I consulted many authorities, but I especially used the following: Gray, Quain, Morris, Cunningham, Gerrish, Eisendrath, Spalteholz, McClellan, Deaver, McLachlin, Taylor, Eckley, Landois, Schafer, Howell, Brubaker, Mouillan, Lovett and Hare. Credit has been attempted in all quotations from the above.

Much dissection has been done in order to ascertain course of nerves, relations of viscera, pathological conditions and their causes, and to the better understand lesions, their kinds and effects. The greater part of the material has been taken from the writer's extensive experience in the diagnosis and treatment of disease, having been a teacher and operator in the American School of Osteopathy since 1899. Many of the conclusions drawn have been from actual cases treated, and we take it that we have as much right to draw conclusions from clinical observations that are as accurate as those drawn from experiments on animals, when cases are diagnosed, lesions found and on the removal of them the patient recovers.

The majority of the illustrations were drawn by Dr. Wm. Most, and I am glad to express my appreciation of his efficient work. I am indebted to D. Appleton & Co., for electrotypes from Dr. Kelly's splendid work.

I am especially indebted to Messrs. Pratt and Sullivan, senior students in the A. S. O. for the preparation of the index.

I am also indebted to my co-laborers in the A. S. O. for many valuable suggestions.

It is the desire of the writer that this work will be of material aid to the practitioner, in the understanding of the human body, that it will stimulate the student to a closer study of the wonderful mechanism, and it is his regret that it is so imperfect, that there are so many things that he is unable to make entirely clear, since, as yet, many of the functions of the body are mere speculations.

M. E. C.

402 Osteopathy Ave., Kirksville, Mo.
May, 1906.

INTRODUCTION

Disease, in the average case, is due to disturbance of structure. Even in cases of disease resulting from abuse, there is often found some structural change. In all diseases, whether from abuse or other causes, there are to be found structural changes, peculiar to the disease. These structural changes, are in a general way, called **lesions.** Lesions therefore, may be muscular, ligamentous, visceral or bony. A bony lesion is one in which the function of the articulations of the bone are impaired. Anything that disturbs the function of a joint, causes a bony lesion. The usual form is the result of displacement of the bone. This displacement is very slight in the average case. A muscular contracture, a ligamentous shortening, an exostosis, or most important and common of all, an inflammatory deposit around the articulation, constitute bony lesions. The function of a joint is movement. Ligaments and muscles restrict this movement. If force is applied, this restriction is in a measure, overcome and consequently the tissues around the joint are injured. Nature sends out an exudate, which forms a splint, the ligaments become thickened, in short, we have a typical lesion. This constitutes a sprain, the most common form of bony lesion. The contracture of these tissues injured by the excessive movement, holds the bone in abnormal position, thus forming the slight displacement or subluxation, so often spoken of in osteopathic literature. These conditions more often follow trivial injuries than they do severe trauma. A person in walking over an uneven sidewalk, may unexpectedly step in a depression and twist the spine. There is a momentary pain and soon it is forgotten. The injured place remains sore. The tissues become thickened. The patient is not aware that it is tender until some osteopathic physician presses directly on the spot. The movement of the joint is practically lost, the foramina partly closed, and there is disturbance of function of everything in relation. Physical culture is not a substitute for osteopathic treatment since the movements of the spine take place in the normal parts, while the place of injury is not moved at all. To reduce such a lesion, passive movement must be directed to the injured joint. By doing this, the function is temporarily restored, the circulation through the part bettered and absorption of the deposits begins. This is followed

by restoration of function of the joint and the adjacent tissues. Such conditions predispose to visceral disease. From this one can see that a knowledge of anatomy is absolutely necessary in order to locate the lesion, to explain the effects and to remove the cause.

Since disease is caused or characterized by structural derangement, and these derangements "produce or maintain the functional disorder," the object of osteopathic examination and treatment is to locate and correct these structural disturbances. Osteopathy, then, is the science of locating and correcting by manipulation, structural disorders that cause or maintain functional disturbances or disease, and the use of common sense regarding the care of the body. Any one can become an invalid by disobeying the laws of nature, consequently structural disorders are not the primary causes of all diseases, yet in such cases there are structural changes that maintain the disturbances which must be corrected before normal function will be regained.

In lesions of the spinal column, there is, in practically all cases a deposit around the joint and a thinning of the intervertebral discs. The object to be attained in the treatment of the spine is to restore normal function, that is movement, to the spinal articulations. This can be accomplished by adjusting the articular surfaces and by stretching the inflammatory tissues deposited around the injured joint.

The essential cause of bony lesions producing disease is pressure. This pressure is exerted on nerves, vessels and other tissues, principally at the intervertebral foramina. The pressure is from the displaced bone or is the result of the inflammatory deposits around the injured joint. On account of this, the nerve connections between the spinal cord and the rest of the body are interrupted, the blood-vessels supplying and draining the spinal cord compressed, the lymphatic vessels impaired and as a result of this, the nutrition of the cord disturbed, the originating of impulses interfered with as well as the transmission of them. Normal circulation to the spinal cord is essential to proper functioning of it; the condition, that is, the mobility of the various vertebral articulations, determines this.

The writer appreciates the fact that there are many exciting causes of disease such as abuse of function, exposure, neuroses and inherited weakness but the underlying cause of all disease is a structural derangement of some part of the body and most important is a derangement of the framework; the spinal column and the ribs in particular.

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THE ATLAS.

The **Atlas** is the most peculiar of vertebræ. It is the uppermost of the vertebræ forming the spinal column and supports the head. For an object to be well supported, there must be little motion between the part supporting and the part supported. This is true of the atlas and occiput, the atlanto-occipital articulation being to all intents and purposes immovable, VERY LITTLE MOTION at least, taking place at this joint in movements of the head. On this account lesions of this articulation are rare as compared with other vertebral articulations, using the term lesion in its usually accepted meaning. In the better use of this term, that is including all affections of the articulation, especially

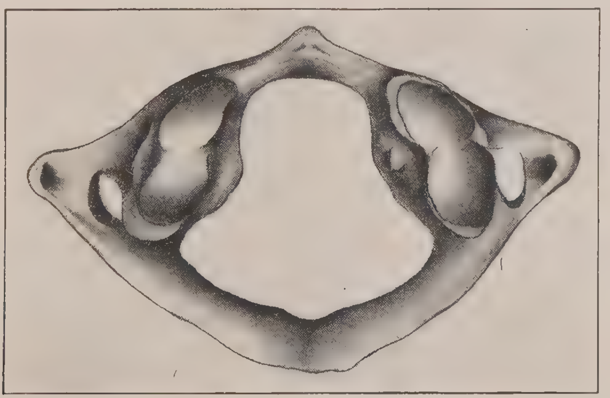

FIG. 1.—The atlas showing the superior aspect. Note the shape and depth of the articular facets.

sprains of the ligaments, a LESION OF THIS ARTICULATION IS QUITE COMMON.

The **atlas is peculiar** in that the BODY IS ABSENT, it being supposedly usurped by the odontoid process of the axis. This is of interest since complete dislocations result in pressure on the spinal cord by the odontoid process from breaking of the transverse ligament, and paralysis of

all parts below follows if pressure is constant and long continued. The absence of the body of the atlas makes it thinner, thus permitting of freer motion of the head on the spinal column, in accordance with the general rule that the smaller the vertebra the greater the arc of mobility.

The **posterior spinous process,** which is developed in all the other vertebræ, **is absent** or, at least, poorly developed in the case of the atlas. There is a rudimentary process or **tubercle** that takes its place, and to which is attached the small posterior recti muscles. Ordinarily, it cannot be palpated even though the neck be in extreme flexion, but in some cases it is possible to distinctly palpate it. If it can be palpated it denotes either (1) an **abnormal development** of the tubercle; (2) an **anterior condition** of the occiput on the atlas; or (3) a **posterior condition** of the **atlas,** the atlas and occiput being displaced posteriorly on the spinal column. The diagnosis is based on (1) **tenderness** over and around the tubercle and (2) **disturbance of function** of the articulations involved. If there is no tenderness in or around the articulations of the atlas and the function is unimpaired, the PROMINENCE OF THIS TUBERCLE is **not pathological** but only a peculiarity.

At the junction of the anterior arches is another **tubercle.** It is of interest only in that the longus colli muscles and the anterior vertebral ligament are attached to it, hence in lesions of the atlas flexion of the head and neck may be impaired indirectly, by affecting these muscles through their nerve supply or attachment and directly, by derangement of the articular facets.

The **superior articular facets** are peculiar on account of their shape, size and the directions that they face. These facets are oval shaped, deeply concave from before backward, converge in front and incline obliquely inward. They are often indented, in which cases they are divided into two unequal parts, thus lessening the mobility of the joint. They receive the condyles of the occipital bone, thus forming a rather secure articulation. On account of the depth of the concavity of the superior facets of the atlas and the prominent convexity of the occipital condyles, dislocation of this articulation either partial or complete, **is rare.** Also the facets act as **inclined planes,** thus assisting spontaneous reduction if the condyles were forced slightly upward on the facets. By muscular contracture the occiput and atlas are approximated, this of itself lessening the mobility of the occipito-atlantal articulation. If in addition, an inflammatory exudate is present from meningitis, la-

grippe or other causes, mobility of this articulation is still further lessened. The principal movement of this joint is an antero-posterior one, thus permitting of a nodding movement of the head.

Another peculiarity is the fact that the articular facets of the atlas, like those of the axis, are ANTERIOR TO THE PLACE OF EXIT OF THE SPINAL NERVES; the facets being posterior in the other vertebræ.

There is a **circular facet** on the posterior surface of the anterior arch for articulation with the odontoid process of the axis. This indentation or facet is called fovea dentalis. On account of this articulation a displacement of the atlas directly backward is impossible unless it carries the axis with it.

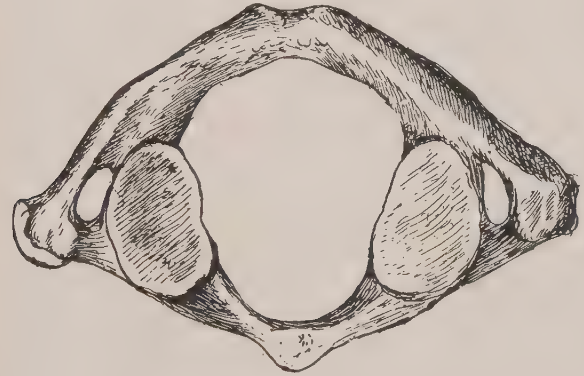

FIG. 2.—Inferior surface of the atlas. Compare with superior, Fig. 1.

The inferior facets are smaller and more nearly circular than the superior, but like them, concave. They face inwards and downwards and are more subject to abnormal movement than are the superior. This is because of the freedom of movement and the leverage exerted on it by the atlas and occiput.

The **movements** of the atlanto-occipital articulation are not very well marked, they consisting principally of a rocking movement of the occipital condyles on the superior facets of the atlas. This has been described as of a ginglymoid character. Morris says: "There is also a slight amount of gliding movement, either **directly lateral,** the outer edge of one condyle sinking a little within the outer edge of the socket of the atlas, and that of the opposite condyle projecting to a corres-

ponding degree. The head is thus tilted to one side, and it is even possible that the weight of the skull may be borne almost entirely on one joint, the articular surfaces of the other being thrown out of contact. Or the movement may be **obliquely lateral,** when the lower side of the head will be a trifle in advance of the elevated side."*

The **head** is so poised on the superior articular surfaces of the atlas that it requires little muscular effort to keep it balanced. If the occiput or atlas become changed in position as a result of a subluxation, the balancing of the head becomes more difficult, that is, more muscular effort is required to keep the head in a normal position. Since the cervical ligaments have little or nothing to do with the balancing of the head, and since the **muscles** connecting the head with the spinal column are the principal factors concerned in holding the head erect, it follows that any disorder of these muscles or the joint itself, will interfere with this function, that is the head is drawn too far to one side or else the balance is lost so that it moves to and fro. Many of the cases characterized by a constant nodding movement of the head are due to some affection of either the joint itself or the mechanism moving the joint so that the muscles are constantly drawing the head out of balance, that is it is drawn too far forward or backward in the attempts of the cervical muscles to keep it poised. If the lesion exists for sometime, the irritation is not overcome by assuming the prone posture but as a rule the movement is decidedly lessened in the worst cases and is stopped entirely in the mild cases. If the prone posture is assumed for several hours as in sleep, the attempts of the muscles to balance the head cease. The above is the principal cause of nodding of the head, the other ones being of less importance.

The first cervical nerves making their exit in relation with the atlas, pass along a groove over the posterior arch instead of through a foramen. this groove being occasionally converted into a foramen. The vertebral vessels also pass along with the first cervical nerve.

The **transverse processes** are unusually large and rough and extend farther outward than those of the other vertebræ. They are perforated by a foramen through which pass the vertebral vessels and vertebral plexus of nerves. Numerous muscles are attached to the transverse processes, in contractured conditions of which the position of the processes is changed. These processes are quite superficial, hence tender

*Morris Human Anatomy, p. 204.

on pressure. Use is occasionally made of this fact in treating hysterical cases, pressure on the transverse processes producing such pain that the patient forgets about the other trouble. The **direction** and position of the processes vary in different individuals. Theoretically they should point directly outward and be midway between the angle of the jaw and the mastoid process. The position of the bone is partly determined by the relation of the tip of the transverse process to the above named landmarks, but it does not necessarily follow that a lesion exists if it is nearer one than the other.

The **position** of the head is sometimes indicative, if not diagnostic, of, a lesion of this articulation. If the CHIN IS DRAWN IN abnormally far, the chances are that the head sets too far back on the spinal column, that is on the atlas; if the **chin protrudes** unusually far, the opposite condition exists. The sterno-mastoid muscles are put on a tension in the first, and relaxed in the second condition.

The **ligaments** binding the atlas to the occiput are arbitrarily divided into anterior occipito-atlantal, posterior occipito-atlantal, two capsular and two anterior oblique. They are band-like, elastic and densely woven ligaments and, if not diseased, hold the superior facets of the atlas and the occipital condyles securely in apposition.

The **anterior occipito-atlantal** ligament is composed of very strong dense fibers that radiate upward and slightly outward from the anterior arch to the anterior border of the foramen magnum. It is in close relation with the anterior common, the capsular and the atlanto-axoidean ligaments.

The **posterior occipito-atlantal** is incomplete on both sides for the passage of the vertebral vessels and the suboccipital nerve.

It extends from the upper part of the posterior arch of the atlas to the posterior border of the foramen magnum. It is not very strong, is not stretched very tightly and does not to a great extent limit motion. Being weaker than the anterior, extreme flexion is more likely to produce a serious effect than is extreme extension. Because of the greater strength of the anterior ligament the front part of the articulation is held the more securely in place than is the posterior thus the latter would respond to a force more quickly than would the former. The capsular do not materially strengthen the joint since they are quite lax. They entirely surround and enclose the occipito-atlantal articulation. They are reinforced and strengthened by the anterior oblique ligaments.

These ligaments are affected in various ways by bony and muscular lesions of the neck. However, the principal effects are those of relaxation and contraction or shortening. If the lesion is irritative the ligaments are likely to become thickened, less elastic and shorter, and thus draw the head quite firmly down on the atlas. In the anemic and malnourished, relaxation takes place with increased mobility.

The **blood supply** to these ligaments comes principally from the verbral while a few twigs are given off by the ascending pharyngeal. The innervation is from the anterior division of the first cervical nerve. In subluxations of the occiput, these ligaments are injured, either torn or badly stretched. This results in a thickening of the ligaments and deposits around the injured part. These conditions interfere with the function of the joint, the blood-vessels, the nerves in relation, the muscles attached and the intervertebral foramina that is the space between the posterior arch of the atlas and the axis.

The brain has a pulsation in the direction where the resistence is least. This is seen best in babies before the fontanelles close. The diastole and systole of the brain are in part made possible in the unyielding box of the cranium by the ebb and flow of the cerebro-spinal fluid. Hill says: "The occipito-atlantal and other vertebral ligaments extend in cerebral diastole, and allow the fluid to escape from the cranial cavity, while in systole, through the elasticity of these ligaments coming into play, it is driven back."* This then is an important factor in the circulation of the brain. Lesions of the occipito-atlantal articulation affect the ligaments and thus interfere with their elasticity. Since in all vertebral lesions the ligaments in relation are always affected, the direct relation of spinal lesions and especially cervical, to brain disorders, becomes the better understood.

The ligaments uniting the atlas to the axis are the anterior and posterior atlanto-axoidean, capsular and the atlanto-odontoid.

The **muscles** attached to the atlas are the **recti capiti minores and laterales, longus colli, obliqui, splenius colli, levator anguli scapulæ** and the **intertransversales.** Most of these are attached to the transverse processes. On account of the length of these processes, the number of muscles attached and the mobility of the articulations, torsion of the atlas and occiput on the axis from muscular contractions often occurs. These muscles contract from thermic influences. This form of stimulation most often

*Schaffer's phys. p. 143.

affects the neck. Nature provides against this by giving man hair which, covering the neck, protects it against exposure. Fashion has decreed that the hair should be worn closely cropped and as a result one of nature's defenses is weakened. In the male the throat is protected in a similar manner by hair from the face.

These muscles, on account of the thermic stimulation, fail to return

FIG. 3.—Showing the small deep muscles at the base of the occiput that are always affected in lesions of the atlanto-occipital and atlanto-axoidean articulations. In the average case of headache these muscles are tender and contractured.

to their normal length and thickness. Landois, in speaking of a contracture says: "This is especially well marked in muscles that have been previously subjected to strong, direct stimulation, or are greatly fatigued, or more strongly acid, or approaching a condition of rigor or have been obtained from animals poisoned with veratin." In man, these con-

tractures come, in the neck, from thermic stimuli, as mentioned above; toxemia, by which the cells are over stimulated; and from lesions of the neck by which the nerve trunks are stimulated, the nerve cells irritated and the muscles put on a stretch on account of change in position of the origin or insertion. It seems that a muscle undergoes a change in structure as a result of prolonged stimulation of its nerve, which condition is readily recognized on palpation and is called a muscular contracture.

When these muscles remain contractured for any great length of time the vertebræ are abnormally approximated, hence the intervertebral foramina are smaller, the circulation through the muscle impaired and consequently the **blood supply** to the cervical **spinal** cord, **medulla** and **pons Varolii** interfered with. The nerve filaments passing through and in relation with, the contractured muscle are also. affected. On the other hand, lesions affecting the innervation of these muscles produce contracture, which in turn produces the above effects.

The upper two or three segments of the cervical spinal cord are in relation with the atlas but provision is made against pressure from movements of the head and neck. This provision is a very large foramen in the atlas portion of the spinal canal. If pressure is exerted on the spinal cord in this region the lesion must necessarily be a complete dislocation. Partial dislocations of vertebræ affect structures attached to the bone and those in the spinal foramina more readily than those in the canal.

The **structures** affected by vertebral lesions in order of frequency are the **ligaments, veins, arteries, nerves** and **muscles.**

The **veins** in relation with the atlas are the **vertebral** and **rami spinales** which collect the blood from the upper cervical segments of the spinal cord and the spinal column. In lesions of the atlantal articulation there is pressure on these veins since they are in close relation with it. The **vertebral,** at this level, drains the **recti** and **obliqui** muscles in relation, **pericranium,** and, through the lateral spinal, the upper cervical **spinal cord.** Often, these veins, by means of an emissary vein through the posterior condyloid foramen, are brought in relation with the lateral sinus. The blood from the **pons Varolii, medulla oblongata** and a part of the upper part of the spinal cord passes into the sinuses of the brain that are in relation.

The **rami spinales** veins drain a part of the cord, its coverings and the vertebræ. The result then of a lesion would necessarily be a venous

disturbance in the parts drained by the vessels that are compressed. This venous congestion affects nutrition of nerve cells located in the affected segments, hence an atlas lesion, by affecting drainage of the first and second cervical segments, disturbs the function of the nerves arising from them.

The **arteries** in relation with the atlas are the **vertebral** and its **lateral spinal** branches which go to the cervical spinal cord. The vertebral, after passing up through the foramen in the transverse process of the atlas, makes an abrupt change in its direction by curving backward and

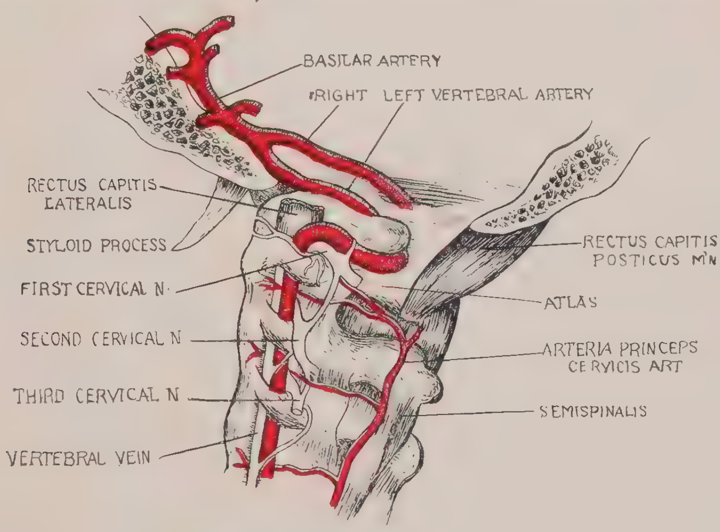

FIG. 4.—Showing the course of the vertebral artery. Note the curve around the superior articular process of the atlas on account of which lesions at the occipito-atlantal articulation readily affect it.

inward behind the articular process. It passes through a foramen formed by the posterior occipito-atlantal ligament into the spinal canal. It then becomes intra-cranial by passing up through the foramen magnum. It joins with its fellow and forms the **basilar.** Before uniting to form the basilar there is given off the **rami spinales, posterior meningeal, anterior** and **posterior spinal** and the **posterior inferior cerebellar.** The **rami spinales** supply the muscles and spinal cord. The **posterior meningeal** supplies the bone and dura mater of the occipital fossa. The **anterior spinal** joins the corresponding artery on the opposite side and

runs the entire length of the spinal cord, being reinforced by branches from the vertebral, ascending cervical, intercostal, lumbar, ilio-lumbar and lateral sacral which follow the corresponding nerves into the spinal canal and accompany the nerve roots into the substance of the cord. The **posterior spinal** remain separate, extend the entire length of the spinal cord and are similarly reinforced. Church says that the arterial

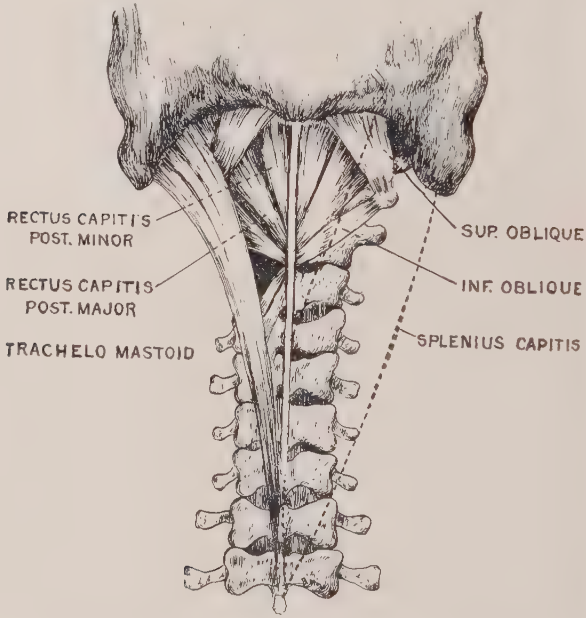

Fig. 5.—Showing deep muscles of back of neck. These muscles are commonly contractured in upper cervical lesions and can be palpated as cord-like bodies which are tender on pressure. The vertebræ are approximated by such contracture.

twigs from these arteries entering the cord are of the "terminal variety and therefore do not anastomose." The **posterior inferior cerebellar** supplies the **medulla oblongata,** a part of the **cerebellum** and the **fourth ventricle, internal ear** and **cerebrum** especially the occipital and tempero-sphenoidal lobes.

The **vertebral** arteries are affected by a lesion of the occipito-atlantal articulation. Pressure on these arteries is the most common effect. As a result the parts supplied by the artery are likely to be affected unless the anastomosis is complete, which thing is almost impossible on

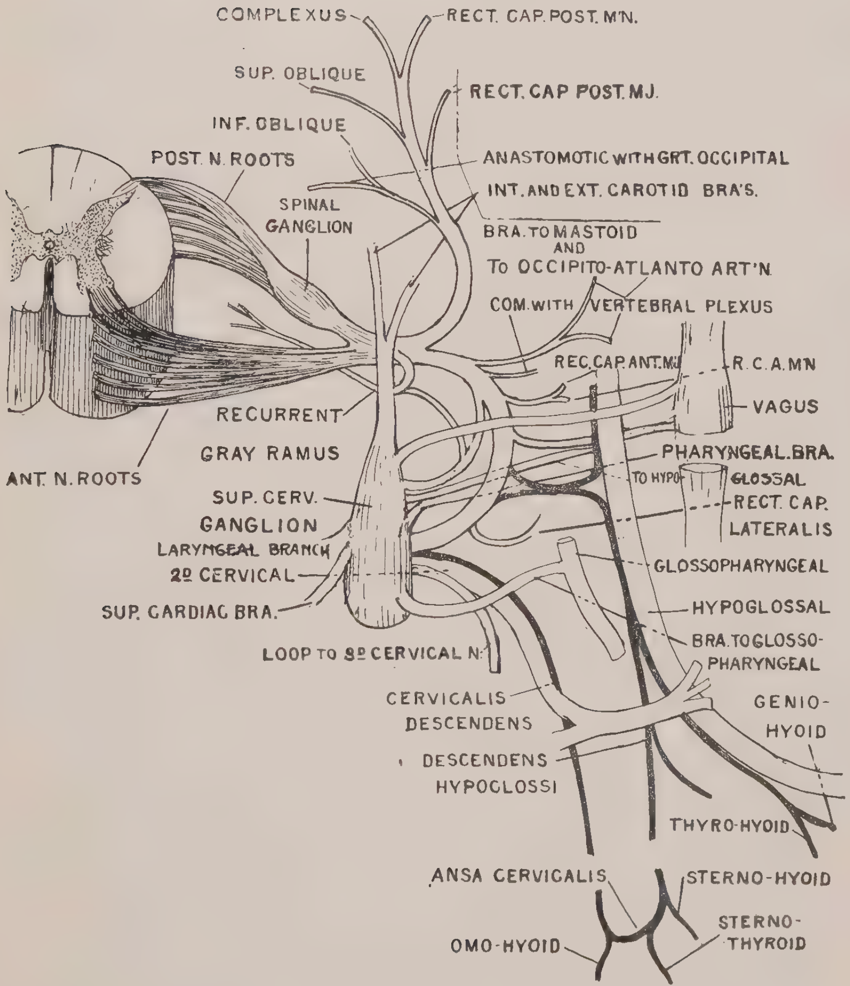

FIG. 6.—First cervical segment of the spinal cord showing branches and connections.

account of the branches being end arteries. The parts to suffer are the spinal cord and its coverings, medulla, pons, cerebellum and quite a large part of the cerebrum, especially the centers for vision. Recalling the function of these parts one can readily see an explanation for disturbances of the eye and other parts whose nerves have their cells of origin here. Vaso-motor nerves accompany and control the size of these arteries. The source of the nerve energy transmitted by these nerves is a point below perhaps in the upper thoracic segments of the spinal cord.

The **nerves** directly in relation with the atlas are the cerebro-spinal nerves and their branches and communications coming from the first and second cervical segments, the **sympathetic gangliated cord** with some of its branches and communications, and the **vertebral plexus.** The anterior and posterior divisions and grey ramus with the vaso-motor nerves of the lateral spinal arteries carry impulses that pass through the intervertebral foramen between the occiput and atlas while the gangliated cord with its ganglia and branches are in relation with the transverse process.

In all lesions affecting the occipito-atlantal articulation the **suboccipital** nerve is involved. This nerve supplies the **recti capiti, obliquii, complexi, genio-hyoid** and **infra-hyoid** muscles. It supplies the **mastoid process** of the temporal bone, the **occipito-atlantal articulation** and, in some cases, **sensation** to the back part of the head. Some say that it helps to supply the meninges of the brain. It communicates directly with the second cervical nerve, ninth and twelfth cranial, superior cervical ganglion and the vertebral plexus around the vertebral artery in relation.

In all lesions involving the atlanto-axial articulation the second cervical nerve with its branches is involved.

A lesion at the occipito-atlantal articulation affects the grey ramus which connects the gangliated cord with the suboccipital nerve. This nerve carries vasomotor and secretory impulses. A filament is given off which joins the **recurrent nerve** which is distributed in the interior of the spinal canal. Langley says "Intermixed with the pale fibers in the grey rami communicantes there are also a few medullated fibres of varying size, even in regions where distinct white rami do not exist."

The **superior cervical ganglion** may be affected by an atlas lesion but not so readily as by lesions lower in the neck. This ganglion is situated in relation with the anterior part of the transverse process of

the second and third, sometimes the first cervical vertebra. Clinically an atlas lesion readily affects this ganglion, judging from the various conditions and effects ordinarily attributed to such lesion. Anatomically the superior cervical ganglion is affected either by direct pressure from the displaced bone or indirectly from contracture of muscles or tightening of tissues, or through interference with ascending branches which are in relation with the upper cervical vertebræ.

The ganglion being located anteriorly to the transverse process, it is the exception for it to be affected by direct pressure, but common for its functions to be disturbed by a tightening of tissues in relation with it. These tissues are always irritated and put on a tension by subluxations of the upper cervical vertebræ. This tightened condition affects the ganglion by direct pressure on it, pressure on its branches and communications, and by pressure on the blood-vessels supplying and draining it.

This ganglion gives off ascending branches which divide into an external or **carotid** plexus and an internal or **cavernous** plexus. The external connects with, or send filaments to, the **fifth** and **sixth** cranial nerves, **external carotid** artery, **dura mater, Gasserian ganglion,** the **tympanic plexus** through the small deep petrosal, and the **spheno-palatine ganglion.** The internal connects with, or sends filaments to, the **third, fourth, ophthalmic** division of fifth cranial nerves, **internal carotid, ophthalmic** and **central artery** of retina, **ciliary ganglion** and the **pituitary** body. The internal branches of this ganglion send filaments to the **ninth** and **tenth** cranial, **superior** and **external laryngeal, pharyngeal plexus** and **superior cardiac.** The inferior branches connect with the **middle cervical ganglion.** The anterior sends filaments to the **carotid** artery and its branches, **sub-maxillary** ganglion and the **middle meningeal** artery. Its branches connect with the ninth, tenth and twelfth cranial and help to supply the nose, tonsils, brain, meninges, medulla, spinal cord and heart.

The **function** of the **superior cervical ganglion** seems to be that of a **relay station** for impulses reaching it from points below. Langley says: "The upper part of the thoracic spinal cord sends out fibers by the anterior roots of the spinal nerves of this region. The fibers make no halt at the ganglia until they reach the superior cervical ganglion. This is a relay station for the sympathetic nerve supply of the whole of the head; in it all the nerve fibers form nerve endings . . . . . each nerve

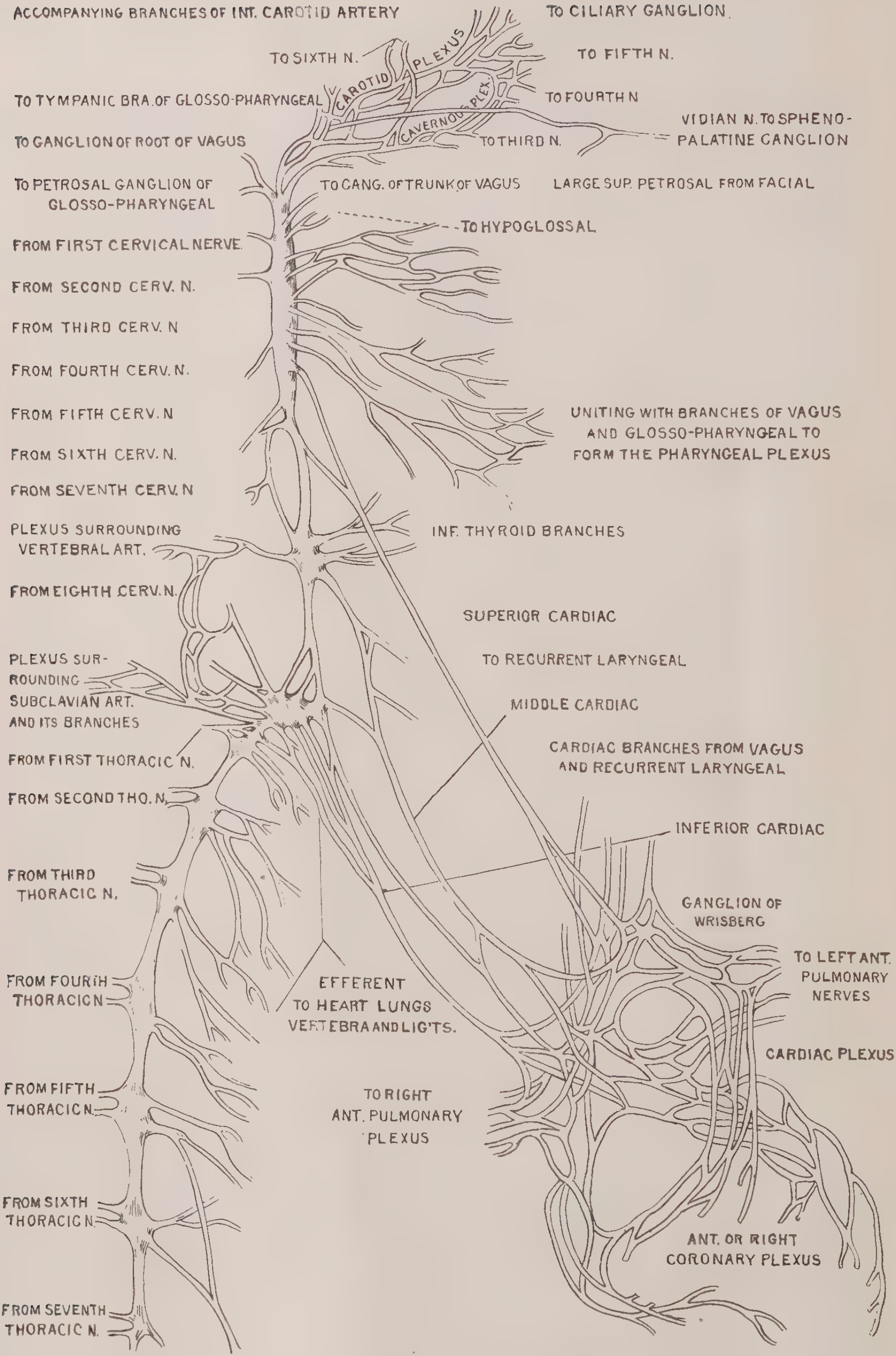

FIG. 7.—Scheme of the cervical sympathetics with their connections, (after Flower).

cell sends off a nerve fiber, which runs to the periphery, where it branches and supplies a group of unstriated muscles or gland cells. On the course of a nervous impulse from the spinal cord to the periphery, there are then two nerve cells, one with cell body in the spinal cord, the other with cell body in the local sympathetic ganglion." Few if any impulses are generated in the superior cervical ganglion; most if not all of them so far as it can be determined, come from the upper thoracic and lower cervical spinal cord. Without doubt there is a nerve line of communication existing between the various parts of the head and face and the upper thoracic spinal cord and the superior cervical ganglion, and the ganglion acts as a relay station, it being on the line of communication. According to Langley, stimulation of the superior cervical ganglion in the cat produces the following effects: (1) dilatation of the pupil, (2) retraction of the nictitating membrane, (3) contraction of the blood-vessels of the skin and mucous membrane of the head and of the salivary and other glands, it being marked in the conjunctiva, the iris, and in most animals in the skin and adjoining mucous membrane of the nose and lips and in the mucous membrane of the hard palate; and (4) secretion from the salivary glands, the lachrymal glands, the glands of the mucous membrane of the mouth, nose and pharynx, and from the sweat glands of the skin where these occur. This ganglion also exerts a tonic effect on the vaso-constrictor fibers, the pupillo-dilator and the motor to the non-striated muscle fibers which it supplies."

Clinically, an atlas or upper cervical lesion produces effects in the parts mentioned above; that is, there are vasomotor, secretory, motor, or trophic disturbances in some part supplied by fibers coming from the superior cervical ganglion. This lesion may be irritative. In such cases it can be substituted for the means used in experiments in which the ganglion is stimulated or inhibited. At any rate the lesion breaks or otherwise impairs the line of communication existing between the base of supply, the nerve cells, and the periphery, some part above. The blood-vessels of the head, face and throat, the involuntary muscles, and the glands and secretory membranes all receive their impulses almost, if not entirely, from or rather by way of, the superior cervical ganglion.

The **vertebral plexus** of nerves surrounds the vertebral artery and is affected in atlas lesions. This plexus is formed by the lowest cervical and first dorsal ganglia which give off slender grey branches which ascend

along the vertebral artery furnishing to it and its branches and the basilar arteries, vasomotor impulses. Since this artery supplies the spinal cord, medulla, pons Varolii, cerebellum and part of the cerebrum, especially the center for vision, and since the amount of blood passing through it is controlled by the size of the vessel and the vertebral plexus

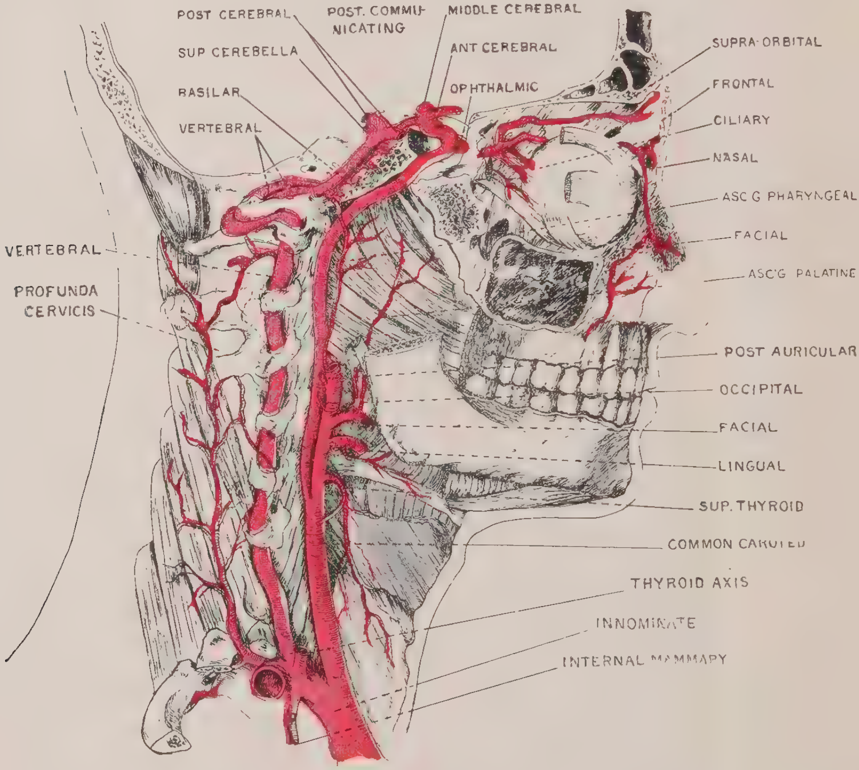

Fig. 8.—Showing the arteries of the cervical region. Note their relation to the vertebræ.

controls its size, it therefore follows that many disorders of the above mentioned structures will arise in case the vertebral plexus is disturbed. It is disturbed by all atlas lesions, since it passes through the foramen and bends around the articular process, therefore being subject to pressure in all deviations of the atlas.

The writer has noted in dissections of this artery that it is surrounded by connective tissue that is closely adherent to it and the parts of the atlas with which it is in relation. Any irritation of this connective tissue therefore, as in sprains or other lesions of the neck, would affect this artery.

Branching from the anterior division of the suboccipital nerve and the ramus communicans are two filaments which unite to form the recurrent or **meningeal** nerve. It enters the spinal canal through the intervertebral foramen where it is distributed to the vertebræ and ligaments, to the blood-vessels of the cord and to the dura mater (Luschka).

In lesions of the atlas the recurrent nerve in relation is affected, this in turn producing trouble with the parts supplied, viz., the atlas and its ligaments, the dura mater in that part of the canal and the blood-vessels of the spinal cord in relation.

The **first cervical segment** of the spinal cord is likely to be affected by an atlas lesion since this lesion interferes with its nutrition, drainage and vaso-motor nerve supply, the vessels and nerves being in relation with the atlas. This segment contains the cells which give rise to nerve impulses that supply the recti capiti, obliqui, complexi, genio-hyoid and infra-hyoid muscles. A disturbance of this segment would cause atony or contracture of some or all of the above named muscles. Every muscle fibre has a cell in the spinal cord which supplies it with tone. If this cell is inhibited there is loss of muscular tone; if this cell is stimulated there is increased tone or contracture. An altered circulation to the cell will cause some pathological effect in the muscles supplied. This segment furnishes a pathway over which impulses pass to or from the upper part of the neck, occipito-atlantal articulation, and the various blood-vessels in relation that supply the muscles, ligaments, vertebræ, meninges and spinal cord. The vaso-motor nerves connect with predominant center in the bulb.

A great many muscles attaching below the atlas connect the head and spinal column. By their contracture the head is drawn tightly down on the spinal column. As a result the tissue between the head and atlas is thinned and the foramina lessened in size, thus impinging on some or all of the structures passing over the posterior arch of the atlas. Such a lesion is diagnosed by the tightened condition of the muscles, absence of irregularity at the atlas, and by approximation of the head and atlas. Tenderness is usually present in and around the joint.

The **atlas** is subject to **lesions** similar in character to lesions of any vertebra. In nearly all cases the occipito-atlantal articulation is not involved, but the head and atlas are abnormally moved on the axis; that is, the lesion in atlas subluxations is in the atlanto-axial articulation. It is the exception for there to be any relative change between the atlas and occiput other than approximation.

Torsion is the most common atlas lesion. This may come from sudden or abnormal movement of the head or it may follow muscular contracture, especially that of the splenius capitus. This form of lesion is diagnosed by tenderness at the articulation, irregularity of the transverse processes, they not being symmetrical, and by impairment of mobility of the joints involved, that is the patient has trouble in extending the neck or rotating the head through an arc of 180 degrees.

Posterior luxations of the atlas are practically impossible except to a very slight degree, such being prevented by the odontoid process of the axis. **Anterior luxations** are fairly common. Such are diagnosed by the way the patient holds the head and by palpation of the transverse and articular processes.

"The relation of the pharynx to the cervical vertebræ makes it possible to diagnosticate vertebral fractures and dislocations by inspection and palpation through the oral cavity; for example, from the relation of the anterior arch of the atlas to the posterior pharyngeal wall, it is clear that when the atlas is dislocated anteriorly it may be recognized as a hard prominence in the posterior pharyngeal wall. It will also be readily understood that diseases of the cervical vertebræ (such as caries) may lead to retropharyngeal abscess or to perforation and the extrusion of pieces of bone into the pharynx."*

This does not apply so well to the minor subluxations of the upper cervical vertebræ, but even in such cases it is possible to palpate by way of the oral cavity, the irregularity caused by an anterior subluxation of the atlas or other cervical vertebræ but not advisable in the average case.

The transverse processes are abnormally near the angle of the jaw and the articular processes quite tender, with undue prominence of tissue over them.

Lateral deviations are unusual, and in case one transverse process is more prominent than its fellow it is probably due to its greater length, the two rarely being of the same length. Such a luxation is diagnosed

*Schultze's Applied Anat. p. 58.

partly by the prominence of the process and partly by the tenseness of tissues in relation.

Approximation of the head and atlas is very frequent. In such cases the lesion is commonly at a point distant from the atlas.

Atlas lesions result from **trauma,** especially sudden and unexpected twists of the head, **muscular contractures** and from **injury** during birth. Anything that carries the head or neck beyond the normal range of movement will produce a lesion of some or all of the cervical articulations. There is often found as a complication, a sprained condition of the ligaments of the affected joint and contracture of the muscles in relation.

Pain is present to some degree in all cases but varies in amount in different cases on account of the difference in the degree of the injury

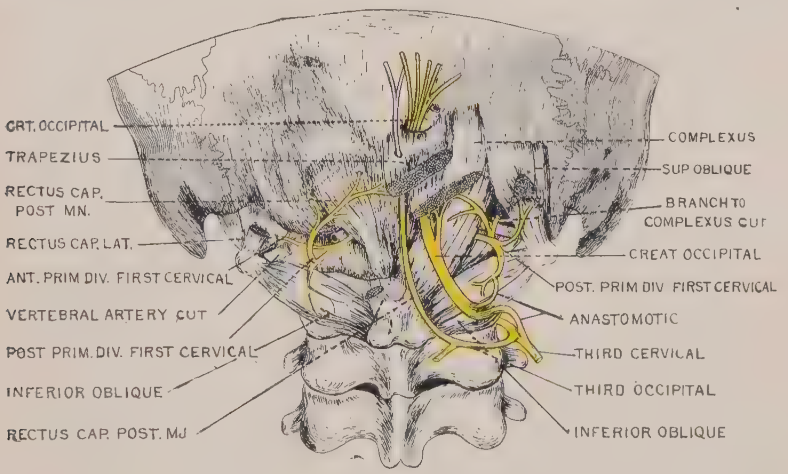

FIG. 9.—Showing course of great occipital nerves. (After Testut) Pressure on this nerve is often effective in the relief of headaches.

and manner of its occurrence. In the average case, nature soon overcomes most of the acute effects and the condition settles into a chronic state. Almost any form of disease of any or every viscus or structure above the point of lesion may occur, the effects coming on gradually in most instances, that is, the lesion acts as the predisposing cause while the abuse is the exciting one. In lesions involving the occipito-atlantal and occipito-axoidal articulations there will be some impairment of practically all the structures of the head and face,

but the eye and its appendages are most frequently and noticeably affected.

The **eye affections** follow such lesions as a result of the disturbance of the various nerves that carry motor, trophic, sensory and secretory impulses to and from the eye and the upper spinal segments. These

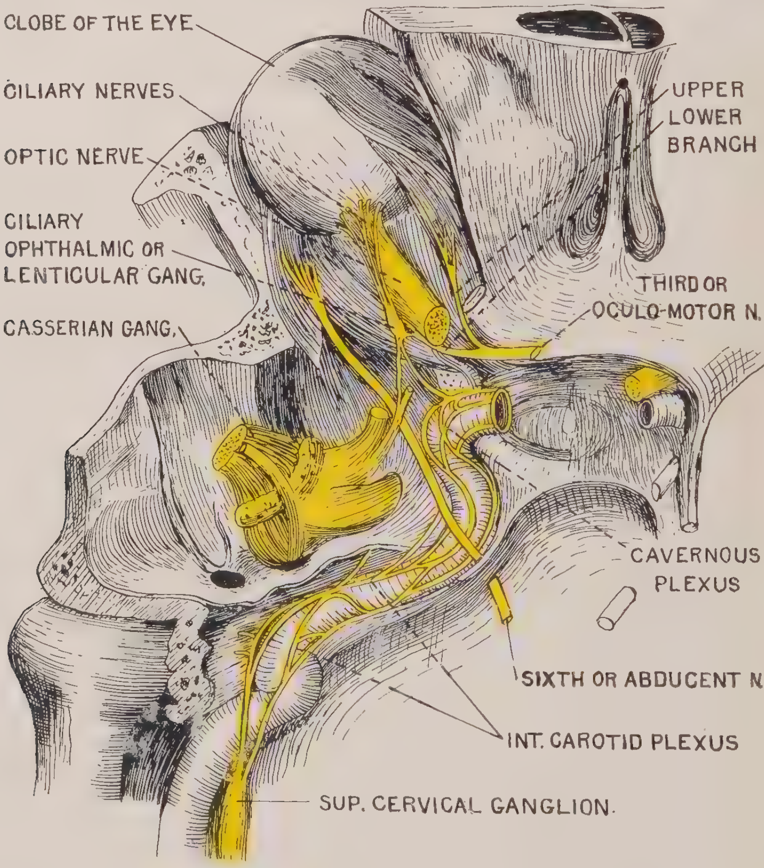

FIG. 10.—Showing nerve pathway from superior cervical ganglion to the eye and to the second, third, fifth and sixth cranial nerves.

impulses, that is the motor, secretory, trophic and vaso-motor impulses arise as low in the spinal cord as the third dorsal segment and pass to the eye via the gangliated cord, superior cervical ganglion, ascending

branches thence over the various connecting fibers to the eye and its appendages.

Motor disturbances of the eye and its appendages result from lesions that hinder the origin of the motor impulses or their transmission to the eye. These impulses arise in the spinal cord and pass to the eye by way of the vertebral plexus and superior cervical ganglion. Atlas lesions interfere with the line of communication existing between the upper segments of the spinal cord and consequently the muscle fibers become weakened. The point of obstruction is the result of direct pressure from the subluxated bone but more commonly from a tightening of the adjacent tissues. It has not been satisfactorily demonstrated that motor impulses pass from the spinal cord to the voluntary muscles of the head and face yet it has been demonstrated that some of the cranial nerves derive at least some of their impulses from the spinal cord. It has been satisfactorily demonstrated that trophic impulses travel from the spinal cord to the different parts of the head and face and in this way the motor effects can be explained.

Strabismus follows a weakening of one of the ocular muscles thus permitting the unopposed muscles to draw the eye to the opposite side.

Convergent squint is due to a paralysis or other impairment of the sixth cranial nerve. This nerve receives a part of its impulses from the cavernous plexus. These impulses are principally trophic in character but according to some, they are partly motor as well. Judging from the immediate effects of certain forms of lesions on the eye, the writer is of the opinion that motor as well as trophic impulses reach the sixth nerve by way of the cavernous plexus.

The common forms of **strabismus** are due to disturbances of the oculo-motor nerve which receives impulses directly from the spinal cord by way of the cavernous plexus. Paralysis of the fourth cranial nerve permits the drawing of the eye-ball up and inward; this being an unusual type of strabismus. Since the cavernous plexus acts as a medium of transmission of trophic and other impulses from the spinal cord to the above named cranial nerves, it follows that any lesion affecting it will cause disturbances in the parts supplied by its branches and communications. A lesion of the atlanto-occipital or atlanto-axoidal articulations will interfere with this transmission of impulses.

The most frequent bony lesion that affects the origin and exit of these impulses is an upper thoracic one. It is a well known fact that

often a blow on or other injury of this part of the spinal column, will produce strabismus almost instantly. A case was reported to the writer in which the physician could produce at will a convergent squint by pressure at the spine of the second thoracic vertebra.

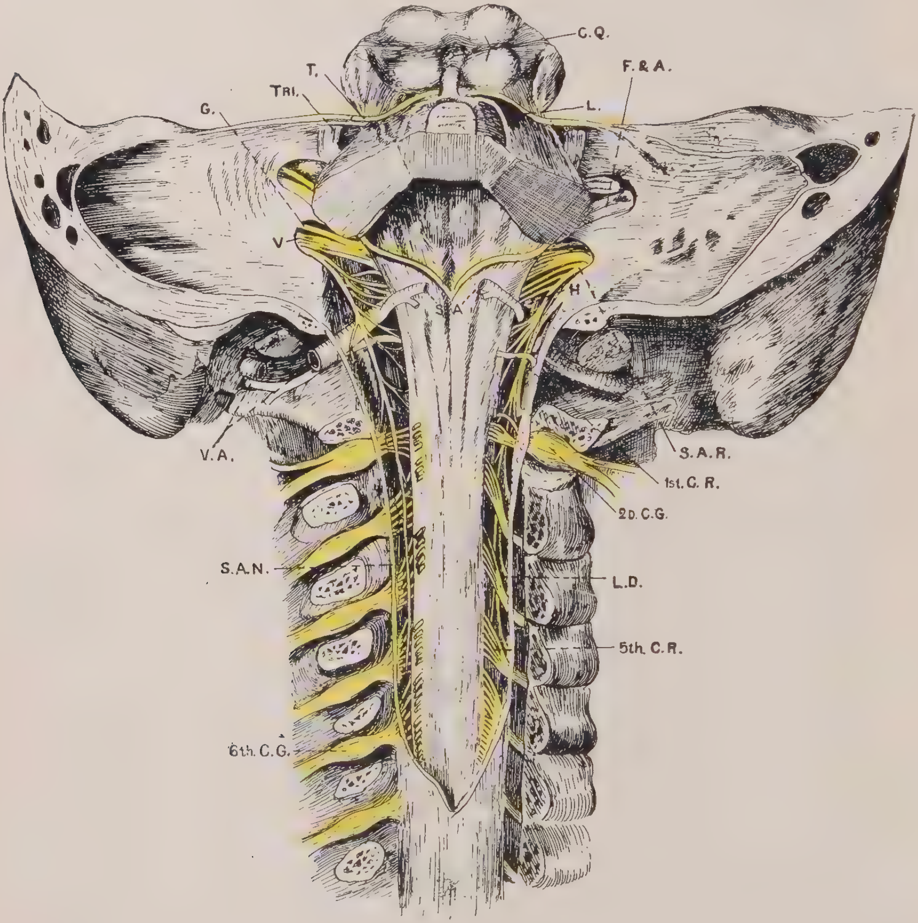

Fig. 11.—Showing the vertebral arches and occipital bone cut away, exposing the cord, etc.; 6th C. G., Ganglion on 6th cerv. n.; S. A. N., Spinal Accessory n.; V. A., Vertebral Artery; V., Vagus n.; G., Ninth n.; Tri., Fifth n.; T., Trochlearis; C. Q., Corp. Quad.; L., Lingula Cerebelli; F. & A., Facial and Auditory; H., Hypoglossus; 2nd C. G., ganglion on 2nd n.; L. D., Lig. Denticulatum.

Myopia and **hypermetropia** in acquired cases, are similarly explained that is they are due principally to trophic disturbances caused by neck lesions. Accommodation of the eye is controlled by the action of the ciliary muscles. Contraction of these muscles increases the convexity of the crystaline lens. If this is of such a degree that the rays are focussed before they reach the retina, it is called myopia. If acquired it is the result of an irritative lesion that causes contraction of the ciliary muscles but if congenital, it is due to the marked convexity of the lens from faulty development. If these muscles become weakened, the lens becomes flattened and the rays of light are focussd behind the retina or rather they are not focussed soon enough and the patient has trouble in adapting the eyes to near-by objects. In either myopia or hypermetropia little can be done aside from the wearing of lenses, if the condition is a congenital one, but if acquired, the conditions can be benefitted by the neck treatment in quite a large majority of all cases. It has been noted by the writer that many patients treated for other disorders caused by neck lesions, have had to change their lenses, the eyes becoming remarkably stronger under the neck treatment. This effect applies better to, or rather is more common in cases in which the eyes are weak but in some apply to cases of near and far sightedness. This clinical fact demonstrates that neck lesions affect the eye, that impulses pass from the spinal cord to the eye, and that almost any acquired disease of the eye may be benefitted by appropriate neck treatment in which adjustment of the vertebral articulations is secured.

Astigmatism, which is commonly characterized by an unequal curvature of the corneal meridians, can be explained in a similar way, if it is an acquired case. The ciliary nerves supply the cornea and crystalline lens. These nerves may be affected by atlas lesions in that impulses to them pass through the superior cervical ganglion, which is involved in lesions of the upper cervical vertebræ. These impulses are carried by way of the ascending internal branch of the superior cervical ganglion. The plexus thus formed (cavernous) sends a branch to, or rather forms a root of, the ciliary ganglion.

The branches of the ciliary nerves supply the cornea forming a plexus around the periphery and forming in the substance of the cornea the stroma plexus. The function of these nerves is not well known but it is supposed that they exert a trophic and motor effect on the cornea, thus controlling its degree of curvature. Morris says that the cornea is

richly supplied with nerves, particularly in its most superficial layers.

Abnormal dilation of the pupil, **mydriasis,** may come from the same cause and is similarly explained.

McLachlin in his applied anatomy says in speaking of the relation of the sympathetic nerve to the eye: "In addition to the ordinary vaso-motor action, the sympathetic is the motor nerve to the dilator pupillæ and also to Muller's muscle—a layer of non-striped muscular tissue bridging across the sphenoidal fissure. The center is probably situated in the medulla, but the fibers pass down the cord some little distance (cilio-spinal region) leaving it through the last cervical or the first two dorsal nerves and entering the corresponding ganglia of the sympathetic trunk, up which they pass to the base of the skull, then along the plexus around the internal carotid artery (carotid and cavernous plexuxes), pass along the sixth nerve and then join the ophthalmic division of the fifth, forming part of its nasal branch, and thence through the long ciliary twigs of the nasal nerve to the radiating fibers of the iris." An upper cervical lesion will interrupt or disturb in some way the passing of these impulses, since they go by way of the cervical sympathetic, which is in relation with the cervical vertebræ. Clinically it is not unusual for dilatation or contraction of the pupil to accompany neck and upper thoracic lesions.

The opposite of mydriasis which is called **myosis,** follows from inhibition or paralysis of the sympathetic or irritation of the third cranial. **Myosis** is usually divided into irritation myosis and paralytic myosis. Irritation myosis most frequently comes from diseases of the brain and meninges. The paralytic form comes from cervical lesions and lesions of the cord above the dorsal vertebræ. These effects are explained by the relations and connections of the superior cervical ganglion with the third cranial nerve. Deaver says "Ligation of the vertebral produces dilation of pupil on same side." If ligature of this artery and plexus produces an effect on the pupil, lesions which affect the vertebral artery or its plexus will also have an effect. Clinically we are warranted to make the statement that atlas lesions affect the vertebral artery and plexus.

Ptosis follows paralysis of the third cranial nerve. This paralysis comes from neck lesions which involve the superior cervical ganglion or vertebral plexus. The internal division of the ascending branches

of the superior cervical ganglion transmits impulses to the third nerve with which it is directly connected.

Blepharospasm, which consists of a spasmodic contraction of the orbicularis palpebrarum muscle, may be caused by an atlas or other cervical lesions affecting the anterior branches of the superior cervical ganglion, which connect directly with the seventh nerve.

This condition is usually accompanied by choreic symptoms, such as a histrionic spasm and some jerking of the head, that is, of the parts supplied by the seventh cranial nerve which is the principal one involved.

Vaso-motor troubles of the eye and appendages are explained by the fact that the superior cervical ganglion either contains the vaso-motor centers, or transmits vaso-motor impulses, for the head and face. Upper cervical lesions affect this ganglion, either increasing or decreasing the impulses, and therefore disturb the size of the blood-vessels of the eye and eye-lids since it is controlled by the condition of this ganglion.

Pterygium consists of a dilated condition of the vessels of the conjunctiva often resulting in its thickening, most frequently at the inner canthus.

This dilated condition comes from some interference with the transmission of vaso-motor impulses to these vessels. **Conjunctivitis** is caused in a similar way. Granulated lids, an advanced form of conjunctivitis, and characterized by the formation of minute abscesses, occurs in chronic cases. A sty or hordeolum is a slightly different form of vascular disturbance but it may come from a similar lesion; most cases however come from infection at the point of a diseased hair follicle. This infection acts as the exciting cause, the lesion being the predisposing cause. The vaso-motor impulses to the above parts of the eye are carried by way of the plexus around the ophthalmic artery, the branches of which supply blood to the eye. This plexus is derived from the cavernous plexus which in turn is derived from the superior cervical ganglion, at least the impulses pass through this ganglion. Contractured muscles of the neck cause congestion of the eye. The patient says that he has cold in the eye. The explanation is like that mentioned above, that the vaso-motor impulses to the eye are inhibited by contracture of the cervical muscles hence a slowing of the current of the blood and increase in size of the lumen of the vessels.

The ophthalmic artery through its branches almost entirely controls the amount of blood to the eye and its appendages. The inner-

vation of its branches comes from the cavernous plexus, which surrounds the artery and sends off filaments with each of its branches. Congestion of one part is commonly accompanied by congestion of other parts; for example, the eye-lids are usually red and slightly inflamed in cases of congestion of the eye ball, as in cases of headache from overuse of the eye. In cases of alcoholic intoxication, the eyes and the tip of the nose become red on account of the action of the alcohol on the vaso-motor nerves, which is an inhibitory one.

Nutritional disorders of the eye, such as **cataract, keratitis** and spots before the eye or **muscæ volitantes,** occur from cervical lesions, since the fibres which carry trophic impulses to the eye pass through the superior cervical ganglion. Atrophy of the optic nerve is brought about in a similar way. The optic nerve is pierced by an artery called the **arteria centralis retinæ** which artery is innervated by the principal terminal branch of the cavernous plexus.

Secretory disturbances, such as **lacrymation,** follow disturbances of the ophthalmic division of the fifth nerve. This nerve receives impulses from and is more closely connected with the cervical sympathetic than any other of the cranial nerves. These impulses pass by way of the superior cervical ganglion and over both the internal and external divisions of the ascending branches.

Summary of eye. Atlas lesion disturb the function of the superior cervical ganglion. This ganglion possibly originates some and transmits most, if not all, of the impulses to the eye by way of its ascending and anterior branches. These branches connect with the second, third and fourth, ophthalmic division of the fifth, sixth and seventh cranial nerves, which nerves have to do with the eye and its appendages. The vertebral plexus of nerves is affected by atlas lesions. This nerve controls, or at least has to do with, the nutrition of the floor of the fourth ventricle at which place are located the cells of origin of nearly all the nerves of the eye. Also this plexus controls nutrition of the occipital lobe of the brain in which is the center for vision.

Cervical lesions, and particularly lesions of the articulations of the atlas and axis, produce **ear disturbances.** Earache or **otalgia** is caused by a disturbance of the sensory innervation of the external auditory meatus, which is supplied to a great extent by the auriculo-temporal branches of the fifth cranial and the auricular branches of the vagus. Pain is most commonly due to pressure. In earache the pressure is

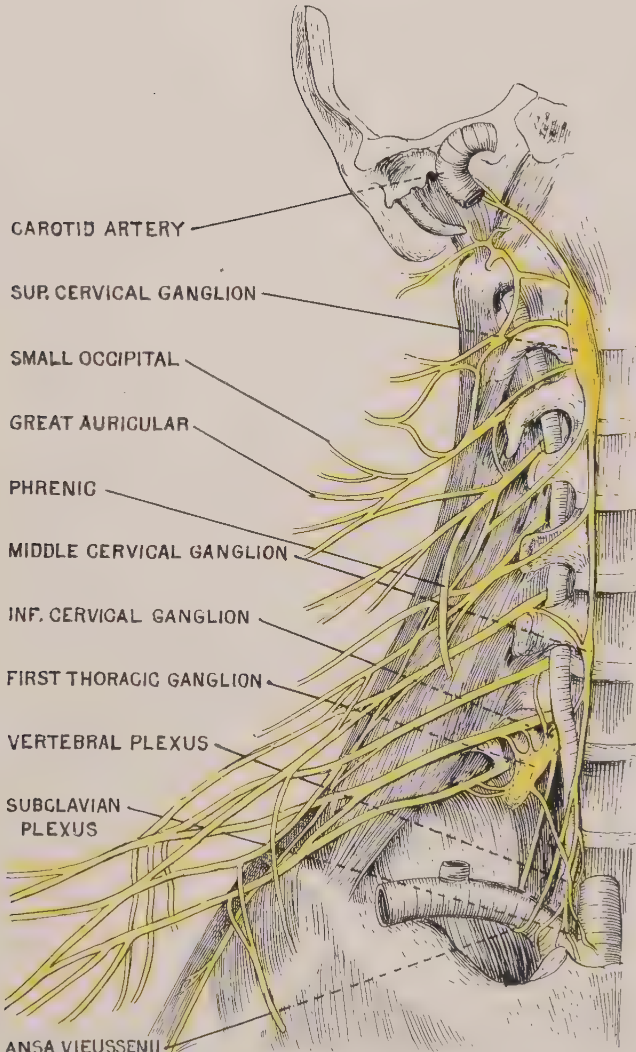

FIG. 12.—Showing cervical nerves and their sympathetic connections.

most frequently a vascular one, that is congestion of the auditory canal, especially of its nerves. Exposure, which so often in children results in contracture of the cervical muscles, is in this way responsible for many cases. These muscular contractures affect the cervical sympathetic ganglia which are directly connected with the fifth and tenth cranial, which supply sensation to the affected part, the fifth by way of the ascending branches which connect with the Gasserian ganglion; the tenth by direct filaments that go from the superior cervical ganglion to the vagus. Atlas and other cervical lesions predispose to muscular contractures, after which the exciting cause, such as exposure, the more readily affects the part. There are other causes, viz., decayed teeth and a dislocated inferior maxilla, in which the fifth nerve is involved. Hilton cites cases in which a decayed tooth produced chronic earache. All vascular disturbances of this part of the ear are very painful on account of the almost inelastic lining of the external auditory canal. In acute attacks heat applied to the back of neck will relieve, sometimes cure, if the trouble is entirely due to contracture of cervical muscles, which is the exception. The correction of neck lesions will cure most chronic cases since these lesions are responsible for the trouble.

Tinnitus aurium is a condition in which the tympanum is in a state of too great tension which results in constant vibration. The impulses generated by the passing of the blood through the internal carotid artery, which is in relation, set in motion the tightened ear drum. The tone of the ear drum is controlled by the tensor tympani muscle. Pathologically, the desiccation of cerumen or contracture of this muscle results in an increased tension. The stopping of the Eustachian tube, which prevents the entrance of air into the middle ear, allows the external air pressure to force the ear drum inward thus interfering with normal vibration. Sound is supposed to be carried by waves. These waves strike the ear drum and set it in motion. If the ear drum is unusually tense it will vibrate longer and more easily than it otherwise would. Neck lesions affect the superior cervical ganglion which, by way of its ascending branches, connects with the fifth nerve, which by way of the Otic ganglion sends filaments for innervation of the muscle that controls the degree of contraction of the tympanum, the tensor tympani muscle. The stapedius is supplied by the seventh, which connects with the superior cervical ganglion by way of its anterior branches. This

connection is probably only a vaso-motor one by which the nerve is nourished.

The mucous membrane of the ear is supplied by the tympanic plexus which is formed by filaments from the ninth, carotid plexus, great superficial petrosal and small superficial petrosal (Morris). The superior cervical ganglion directly **connects** with nearly all the above nerves. In vascular or secretory disturbances of the mucous membrane of the ear the tympanic plexus is implicated, usually it is at fault, and since its vaso-motor and secretory impulses pass through or arise in the superior cervical ganglion a lesion of the atlas or axis may cause CATARRH of the ear, a lessened or increased secretion, OTITIS MEDIA, or even ABSCESS.

The **auditory nerve,** as far as we can ascertain, has no direct connection with the superior cervical ganglion. In the aqueductus Fallopii it connects with the seventh and its blood supply is in a measure regulated by the vertebral plexus. The internal auditory artery, a branch of the basilar, supplies the internal ear. The vertebral plexus supplies the basilar artery and its branches. Lesions of the upper cervical vertebræ affect the vertebral plexus, hence would in many cases affect the blood supply of the internal ear. Vascular disturbances of the middle ear come from lesions affecting the innervation of its arteries, which are: the tympanic branch of the internal maxillary, petrosal of the middle meningeal, and stylo-mastoid of the posterior auricular. The vaso-motor nerves of these arteries come by way of the superior cervical ganglion by way of its anterior and superior branches. The anterior sends filaments to the middle meningeal artery and its branches; the ascending branches supply the carotid and its branches.

Deafness, partial or complete, may come from impairment of the mechanism receiving the sound impulses or from an impairment of the mechanism conveying them. The first is due to disease of the auditory nerve, the second usually to disturbance of the tympanum or ossicles. Neck lesions, as pointed out above, affect both. To differentiate between the two, use the sound test. If the patient can hear at all the auditory nerve is not paralyzed; if patient can not hear watch or tuning fork, when placed in relation with the ear but can hear it when placed between teeth or against mastoid, the trouble is in the sound-conveying mechanism.

Summary. Sensory disturbances of the ear follow cervical lesions

affecting directly or indirectly the vagus or fifth cranial; disturbances of the tympanum from lesions affecting the fifth, seventh or ninth cranial nerves; disturbances of the inner ear from cervical lesions affecting the vaso-motor supply which comes from the vertebral and carotid plexuses.

The NOSE may be affected as a result of atlas or other cervical lesions. Catarrh of the nasal mucous membranes is the most common affection.

Catarrh is a condition characterized by congestion of a mucous membrane with disturbed secretions. This congestion is most frequently the result of vaso-motor inhibition which permits an increase in size of the blood-vessels affected. This vaso-motor disturbance in the head and face comes from neck lesions. The connection is traced through the ascending branches of the superior cervical ganglion and their connection with the fifth cranial, the branches of which supply the nasal mucous membrane. The OPHTHALMIC and INTERNAL MAXILLARY arteries through their branches supply most of the nasal mucous membrane, and these arteries are supplied by the cavernous plexus and anterior branches of the superior cervical ganglion. A simple experiment would clinically prove the connection between the neck and nose. Expose the back of the neck to a draught. Within a few minutes the nose will begin to feel stopped and coryza sets in. The thermic stimulation causes the cervical muscles to contract. This contraction interferes with the passing of vaso-motor impulses through the sympathetic. Since the nose gets its vaso-motor supply from this source its mucous membrane necessarily suffers. If the atlas or axis is displaced there is chronic congestion of the nasal mucous membrane and we call it **chronic catarrh.** These lesions predispose to muscular contracture of the neck, that is, the muscles more easily contract, hence a very slight thermic stimulation would readily affect them. On this account a case with cervical lesions and in a bad climate is hard to cure.

Hay fever, being a vaso-motor disease, is explained in a similar way. The cervical lesions impair the passing of nervous impulses to the nasal mucous membrane. It becomes diseased, thus more irritable, and certain kinds of stimuli affect it more readily than others. The pollen of flowers acts as an exciting cause, the lesion being the predisposing cause. Change of climate may relieve because the exciting cause is removed, or rather the patient is removed from the exciting cause, but not cured. As in other cases in which cures are effected, the predis-

posing cause, the bony lesion, must be corrected. This lesion is most often found at the articulations of the atlas and axis. In general, all vaso-motor and secretory disturbances in this region are similarly explained.

Anosmia may come as a result of disturbance of the fifth nerve since a certain amount of secretion is necessary to the normal sense of smell.

Epistaxis may also come from neck lesions. The application of cold to the back of the neck will often stop it, this indicating a connection between the neck and the nose. The explanation is that the cold has a tonic effect on the vaso-motor nerves controlling the blood-vessels of the nose.

The various affections of the **brain** most often come from neck lesions. This is explained by the fact that the vaso-motor supply arises in or passes through the cervical sympathetic. These impulses thus generated follow the plexuses around the arteries, viz., vertebral and carotid arteries and their branches. The amount of blood in these vessels is controlled by their size. Their size is controlled by the condition of the vaso-motor nerve supply to them. If lesions exist which disturb this there must be some effect in the part supplied. Cervical lesions do affect these vaso-motor nerves, hence the vascular and sensory disturbance. Although many cerebral troubles come from other sources, such as abuse, many come from lesions in the neck. Apoplexy, cerebral softening, congestive headache, motor and sensory disturbance, such as spasms and pain, depend on the amount and character of the blood sent to the brain.

According to Langley, it has not been definitely demonstrated that the blood-vessels of the brain have vaso-motor nerves but according to the observations of many, there seems to be no doubt about it. In speaking of the blood-vessels of the pia mater Landois says: "The blood-vessels of the pia mater are naturally in part under the influence of the vaso-motor nerves accompanying them; in part their size may be influenced from remote parts of the body. Irritation of the sympathetic affects only the vessels of the same side, but does not alter the blood pressure upon the other side. Paralysis of the vaso-motor nerves, also by means of narcotics, causes dilatation of the vessels. The vessels contract strongly in death." From observations made in clinic cases it seems to be demonstrated beyond a doubt that the vessels of the

meninges and possibly those of the brain substance have nerves which have their origin in the spinal cord, at least lesions of the spine affect the circulation of blood through these vessels.

The vaso-motor,motor and secretory supply to the face comes from or is controlled to a great extent by the cervical sympathetic. The vaso-motor impulses travel by way of the superior cervical ganglion, anterior and ascending branches, to the carotid artery, thence over

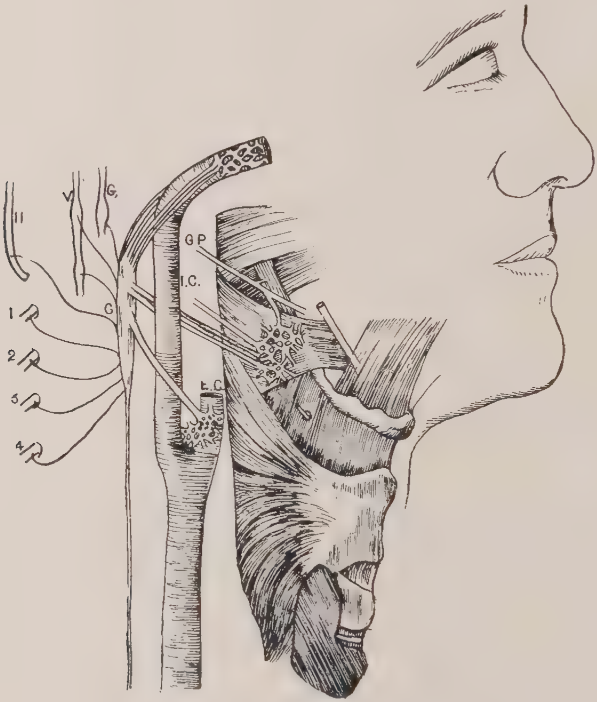

FIG. 13.—Showing connections of superior cervical ganglion; the upper cervical; and 9, 11 and 12 cranial nerves with the carotid arteries and the pharynx. 1, 2. 3, 4, first four cervical nerves; II hypoglossus; V., vagus; G. P., glosso-pharyngeal; I-C.,internal carotid; E. C., external carotid; G., superior cervical ganglion. (After Cunningham).

facial branches to the face. Sometimes we are inclined to the belief that the nuclei of the seventh nerve are affected by vascular changes, these following neck lesions affecting the vertebral artery.

Since it has not been conclusively demonstrated that any motor impulses pass to the voluntary muscles of the head and face by way of

this ganglion, or at least the physiologists disagree about it, we are forced to the conclusion that these motor effects that undoubtedly come from neck lesions, are the results of vaso-motor disturbances that affect the nutrition of the nerve cells or as stated above, the nuclei of origin of the seventh nerve.

In regard to the passing of motor impulses to voluntary muscles of the eye Landois says: "The motor fibers for the unstriated muscles of H. Muller in the orbit and the lids and for the external rectus, pass in part through the dorsal nerves from the first to the fifth (in the cat)." These impulses pass by way of the superior cervical ganglion; that is according to this, it does send, by way of its ascending branches, impulses to voluntary muscle fibers, since the external rectus is a voluntary muscle.

Sensory disturbances follow lesions affecting the fifth cranial nerve. These sensory disturbances are explained by (1) the effect of lesion on the blood supply or nutrition of the cells of origin of the fifth cranial nerve and (2), disturbance of its long or descending root which is sensory and runs as low in the spinal cord as the third cervical segment. The cervical lesion affects the circulation in the cervical spinal cord where the cells of this root of the fifth cranial nerve are disturbed.

Under vaso-motor disorders of the face we have classed eruptions, blotches, pathological blushing and anemia. Under motor disturbances, Bell's paralysis, tic douloureux and histrionic spasms. Under sensory affections, facial neuralgia, toothache and sensory paralysis.

The above mentioned nervous and vascular distribution and connections explain these various troubles since atlas and other cervical lesions affect all the nerves mentioned. This has been proven clinically as well as anatomically. Secretory disturbances may follow cervical lesions, the most striking being hemidrosis, that is sweating of a lateral half of the face. The fifth cranial is supposed to control secretion of sweat of the head and face. This nerve connects with the cervical sympathetic.

The writer has treated a few cases of hemidrosis and with uniform success. In all the cases, there was found a lesion at the atlanto-axoidean articulation. In some of these cases, only a few treatments were necessary to reduce the lesion and thus effect a cure.

The **pharynx** is supplied with blood by the ASCENDING PHARYNGEAL, ASCENDING PALATINE branch of facial, and the POSTERIOR PALATINE from the internal maxillary. The **nerves,** vaso-motor, motor and sensory,

are derived from the pharyngeal plexus which is formed by the vagus, glosso-pharyngeal and branches from the cervical sympathetic. The principal DISEASE is **pharyngitis** which consists of an inflammation of its mucous membrane. Most frequently the congestion preceding and accompanying the inflammation is from a vaso-motor disturbance. This comes from a variety of causes, but the cervical lesions are most important in CHRONIC SORE THROAT. Referring to the arteries, it is seen that the vaso-motor supply would be affected by cervical lesions since the vaso-motor impulses arise in or pass through the cervical sympathetic, thence to the pharynx by way of the ninth and tenth cranial nerves. Dysphagia and "sore throat" are secondary to the inflammation.

The **tonsils** are often affected by neck lesions, either through their nerve or blood supply. Their nerve supply is from the ninth cranial and Meckel's ganglion. Both of these nerves are connected with the superior cervical ganglion. The ninth cranial gets most of its motor impulses from the upper spinal cord. The nerves following the arteries are many, since the tonsil is exceptionally vascular. The external carotid by way of the ascending pharyngeal, the facial, through the tonsillar and ascending palatine, the lingual and the internal maxillary send branches to them. These arteries are supplied with vaso-motor impulses through the superior cervical ganglion, by way of the ninth cranial hence vascular disturbances in the tonsil when this ganglion is affected.

The **larynx,** which forms the entrance to the respiratory tract and is the organ for the formation of the voice, is affected by cervical lesions. The NERVE SUPPLY to the larynx is through the SUPERIOR and RECURRENT or inferior laryngeal nerves. These connect by way of the vagus with the superior cervical ganglion and cervical nerves.

The innervation of the hyoid muscles comes almost entirely from the upper three cervical segments by way of the cervical plexus. These muscles when contractured draw the hyoid bone out of normal position and the voice is affected. The BLOOD supply comes from the superior and inferior thyroid arteries. The superior is a branch of the external carotid, hence is innervated by branches of the cervical sympathetic. The inferior thyroid is a branch of the thyroid axis and is innervated by the inferior cervical and stellate ganglia. The veins, the superior, middle and inferior thyroid, empty into the internal jugular.

The **salivary** glands may be affected by cervical lesions. The parotid gland is innervated by the facial, great auricular, glosso-pharyngeal, by way of the auriculo-temporal branch of the fifth and the carotid plexus. All these nerves connect with or are supplied by impulses from the cervical sympathetic system.

Some secretory impulses arise in the upper thoracic spinal cord, pass out over the anterior nerve roots, common nerve trunk, anterior division and white ramus, into the gangliated cord, thence upward by way of the superior cervical ganglion.

It also may be affected through its blood supply or drainage.

The other salivary glands are in a similar way affected by a neck lesion.

The **mastoid cells** are innervated by a branch from the suboccipital nerve. Lesions of the occipito-atlantal articulation always involve this nerve, hence the effect on the mastoid cells.

Atlas lesions often irritate the nerve innervating the rotator muscles of the head. This results in chorea or other forms of disease characterized by spasmodic contractions of the cervical muscles. It is a well known fact that chorea or some form of tic, comes oftenest from lesions in the upper cervical region. The explanation is that the lesion interferes, by pressure or other means, with the regular transmission of motor impulses to the muscles of the neck. There being a spasmodic transmission of these nerve impulses, there is a spasmodic effect characterized by irregular muscular contractions.

Spasms may also be caused by atlas lesions. In such cases, perhaps the medulla is affected as a result of the lesion interfering with its blood-supply which is controlled by the vertebral vessels and plexus of nerves.

Epilepsy may come from a similar cause if the higher centers are involved. The circulation to the brain is governed to a certain extent by the superior cervical ganglion hence any vascular disturbance, of which epilepsy is one, may come from a lesion involving it.

Summary of the atlas. Lesions of the atlas involve the atlanto-axoidal articulation oftener than the occipito-atlantal. When this articulation is disturbed the cervical sympathetic system is impaired. The superior cervical ganglion sends filaments to, or communicates with, all the cranial and upper four cervical nerves, hence the varied effect of a lesion involving it. This ganglion is in relation with the

atlanto-axial articulation and would be affected by a lesion of it. The vertebral plexus is also in relation and would necessarily be involved by a lesion. As a result the spinal cord, medulla, pons, cerebellum, pituitary body, fourth ventricle and a part of the cerebrum would be disturbed by an atlas lesion.

Vaso-motor effects occur from atlas lesions in all parts supplied by the superior cervical ganglion and vertebral plexus, since these impulses pass through the ganglion and possibly the plexus. **Motor** effects in the INVOLUNTARY muscles, that is the smooth muscle fibers, result from effect of lesions on the superior cervical ganglion through which these impulses pass on their way from the spinal cord to the muscles. The motor effects on the VOLUNTARY muscles are best explained by the disturbance of circulation to the motor cells in the brain. In proportion

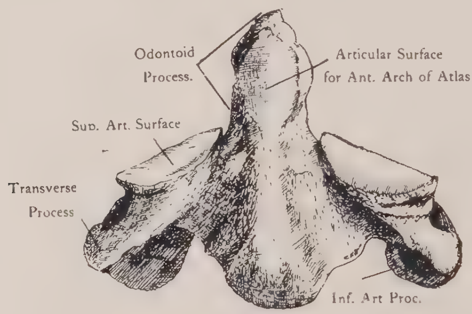

FIG. 14.—Showing front view of axis. Note the superior articular surfaces.

to the trophic disturbance of these cells, so is the effect on the muscles supplied. The **vaso-motor** nerves control the amount of blood to, hence the trophic condition of, the cells. Some of the **secretory** and probably all vaso-motor effects from atlas lesions, are explained by disturbance of the superior cervical ganglion, since the secretory and vaso-motor impulses to the glands above, pass through this ganglion. The **trophic** effects are explained by the vaso-motor disturbances. The **sensory** effects are explained by the disturbance of nutrition of the sensory cells of origin of the long or descending root of the fifth cranial, and by the fact that the ascending branches of the superior cervical ganglion connect with the Gasserian ganglion and thus the pain is a referred one. As in motor disorders the effect on the sensory nerves is explained by the trophic disturbances of the cells giving origin to those nerves.

In the explanation of the effects of an upper cervical lesion we assume that the superior cervical ganglion is affected. Clinically there is no doubt about it. If the lesion affects this ganglion the rest of the explanation is simple. In all cases of lesions of the articulations of the atlas, the adjacent tissues are affected and I believe that the best explanation of the distal effects is that the tightening of the tissues disturbs the function of the ganglion. The continued drawing of the muscles and ligaments interferes with the function of all structures in relation.

THE AXIS.

The **axis,** so named because it forms a pivot upon which the head and atlas rotate, is the strongest and next to the atlas the most peculiar vertebra in the cervical region. The most striking peculiarity is the odontoid process which represents the displaced body of the atlas. The check ligaments, which limit rotation of the head, are attached to it. This process is of interest in that in hanging or in dislocation from any cause it is thrown directly against the spinal cord, the transverse ligament being broken. The laminæ are exceptionally strong, being thick and prismatic on cross section. The spinous process is very large, markedly bifid and deeply grooved on its under surface. This process forms an important osteopathic landmark of the neck. The superior facets are placed over the pedicles and the anterior root of the transverse processes. They are nearly circular, slightly convex and face upward and outward. The second nerve passes out posterior to the facet which is true only of the atlas and axis. The inferior facet is not directly beneath the superior as in other vertebræ but posterior, thus resulting in the weight of the head being transmitted through an angle instead of a straight line. The transverse processes are short, sometimes rudimentary, and are perforated by the foramen for the passage of the vertebral artery.

The **atlanto-axoidal** articulation permits of nearly all movements, the facets being very shallow. Rotation of the head and atlas on the axis is the most important and most marked. In a supposed lesion of this articulation a test of mobility should be made, there being some restriction to the normal degree of rotation of the head if a lesion exists.

The principal **landmark** of the axis is the bifid spinous process. It is ordinarily the first bone to be palpated below the occiput in the median

line of the neck. The articular processes can quite distinctly be outlined and particularly so if a lesion of the atlanto-axoidal articulation is present. In such cases there is a prominence of the joint, which is best palpated midway between the spinous and transverse processes, which is partly the result of the irregularity and partly the result of a thickening of the muscles and ligaments over it.

The **ligaments** involved by an axis lesion are those uniting the axis to the atlas, the occiput and the third cervical.

Those uniting the atlas and axis are the anterior and posterior

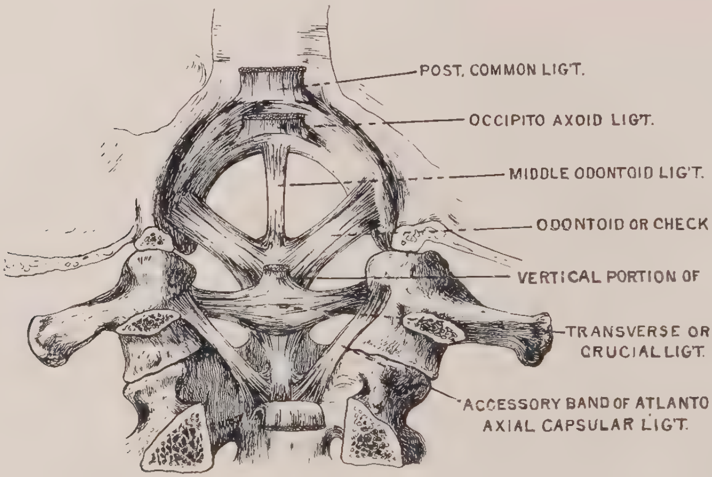

FIG. 15.—Showing the vertebral arches cut away exposing the ligaments connecting the axis and atlas and occiput.

atlanto-axoidean, two capsular, the transverse ligament and the atlanto-odontoid.

The atlanto-axoidean ligaments are thin, but strong, elastic membranes. In that strength with mobility is necessary, these ligaments are well adapted.

The posterior atlanto-axoidean is attached above to the lower edge of the posterior arch of the atlas and inferiorly to the upper edge of the lamina of the axis. It has a layer of elastic tissue in it. It is in relation with the inferior oblique muscles and is perforated by the second cervical nerve. This is of interest in that in subluxations of the

axis this ligament is more or less involved hence a disturbance of this nerve as it passes through the ligament.

The anterior atlanto-axoidean is in its middle portion, a continuation upward of the anterior common spinal ligament, and it in turn is continued upward and helps to form a part of the anterior atlanto-occipital ligament.

The important ligaments uniting the occiput with the axis are the check or lateral occipito-odontoid and the central odontoid or suspensory.

The capsular are important in that they are necessarily injured in all dislocations since they completely surround the atlanto-axoidean articulation.

The most important of these ligaments is the transverse, so far as the life of the individual is concerned. It is attached on either side to a tubercle on the lateral mass of the atlas and passes behind the odontoid process, thus dividing the spinal foramen into two parts, the anterior containing the odontoid process and the posterior, the spinal cord, If this ligament were to become broken, the odontoid process would be forced into the spinal cord and instant death result. Posteriorly, there is found a vertical portion which is attached above to the anterior margin of the foramen magnum, and on this account it is called the crucial ligament.

This latter ligament is sometimes injured in hyper-extension of the head. Morris says: "The suspensory ligament is tightened by extension and relaxed by flexion or nodding; the lateral odontoid not only limit the rotatory movements of the head and atlas upon the axis, but by binding the occiput to the pivot, round which rotation occurs, they steady the head and prevent its undue lateral inclination upon the spine."

These ligaments restrict movements of the head and help to poise it on the spinal column. In speaking of the occipito-atlantal and the atlanto-axoidean joints, Morris further says: "The ligaments which pass over the odontoid process to the occiput are not quite tight when the head is erect, and only become so when the head is flexed. If this were not so, no flexion would be allowed; thus muscular action, and not ligamentous tension, is employed to steady the head in the erect position. It is through the combination of the joints of the atlas and axis, and occiput and atlas (consisting of two pairs of joints placed symmetrically on either side of the median line, while through the median line there

passes a pivot, also with a pair of joints) that the head enjoys such freedom and celerity of action, remarkable strength and almost absolute security against violence, which could only be obtained by a ball and socket joint; but the ordinary ball and socket joints are too prone to dislocations by even moderate twists to be reliable enough when the life of the individual depends on the perfection of the articulation, hence the importance of this combination of joints." These twists do take place which impair the joint itself and some or all of the structures in relation. A lesion will cause tenderness in, thickening of, and sometimes rupture or at least a stretching of these ligaments. These ligaments are subject to sprains as are the ligaments of other more freely movable joints. Moullin, in speaking of sprains of the back and neck says: "One of the most singular features in connection with these sprains is the way in which the backbone itself and the muscular and ligamentous structures around it are overlooked and ignored. Even in the ordinary accidents of every day life there is a great tendency to lay everything that is serious or lasting to the spinal cord. In railway cases there is no hesitation at all; if any serious result ensues it must be the result of damage this structure has sustained, or of inflammation following it; little or no attention is paid to anything else. Yet it is difficult to see why the other structures should enjoy immunity. The vertebral column may be strained, especially in the cervical and lumbar regions; the ligaments torn or stretched; the nerves bruised or crushed; the smaller joints between the segments twisted and wrenched; the muscles detached from their bed and torn across or thrown into such a state of cramp that they become rigid and unable to act with freedom; or the fibrous sheath which contains them and helps to secure the bones laid open and filled with blood." Undoubtedly these ligamentous, and muscular disturbances as well as bony lesions are often overlooked. In trauma in which there are marked lesions, these ligaments are torn at many points and such heal with difficulty.

The **muscles** in relation with and which would be affected by an axis lesion, are the LONGUS COLLI, INFERIOR OBLIQUE, RECTUS CAPITUS POSTICUS MAJOR, SEMISPINALIS COLLI, INTERSPINALES, MULTIFIDUS SPINÆ, SCALENUS MEDIUS, SPLENIUS COLLI, INTERTRANSVERSALES, LEVATOR ANGULI SCAPULÆ and TRANSVERSALIS CERVICIS. The lesion affects the muscles in one of two ways, either by interfering with the nerve and blood supply or by change of position of the axis thus ap-

proximating or separating the origin and insertion. This effect of change of position will be considered here; that from nerve disturbances under effect on nerve.

The **longus colli** has to do with flexion, rotation and lateral flexion of the neck. The vertical portion is attached anteriorly to the lateral part of the body of the axis and is the principal part directly involved by axis lesions. When impaired, there is difficulty in flexion of neck or else the neck is held in position of partial flexion, that is, extension is incomplete, the patient not being able to look directly upward.

The **inferior oblique** has its origin in the side of the spine of the axis and is inserted in the tip of the transverse process of the atlas. If irritated it approximates the origin and insertion, that is the atlas is tilted or the transverse process is twisted backward. The head with the atlas is drawn to one side and backward. This muscle seems to be affected in all lesions of the atlas and axis and can be palpated quite deeply in, as a hard, contractured band in relation with the articular process of the axis, its course being up and out. I believe it is more frequently affected than any other of the cervical muscles.

The **rectus capitus posticus major** has to do with extension of the head and is involved in the various tics and choreas. In disturbances of the finer movements of the head this muscle is usually at fault.

The **semispinalis** has to do with extension, lateral flexion and rotation to the opposite side. This muscle is also involved in most of the motor disturbances of the head and neck.

The **interspinales** extend the neck and have to do, when irritated, with approximation of the vertebræ.

The cervical portion of the **multifidus spinæ** muscle arises from the articular processes of the fourth to the seventh cervical vertebræ and is inserted into the spines of the vertebræ above. It has to do with extension, lateral flexion and rotation to opposite side. It is one of the deep muscles of the neck and its condition has to do with the circulation of the spinal cord. If it becomes contractured, there is obstruction to venous drainage of the spinal cord in that region. It is also involved in chorea, hysteria and spinal meningitis. Curvatures of the spine in general, come in part from atrophy of this muscle.

The **splenius** is important on account of the part it plays in many cases of torticollis, especially recent cases. McClellan says: "The action of the splenii aids that of the sterno-mastoid muscles. When the two

muscles on both sides contract together they assist in holding the head erect. The action of either of them (the two portions working together) is to draw the head and the upper cervical vertebræ toward its own side. When this contraction is permanent it may produce wry neck and may

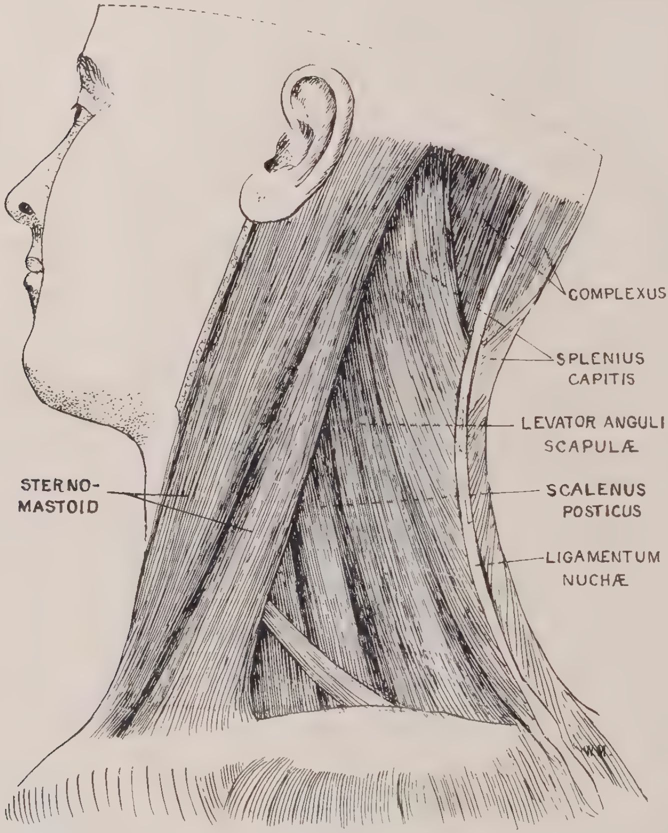

Fig. 16.—Showing the muscles that have to do with producing torticollis. Note the sterno-mastoid and splenius.

be confounded with the action of the opposite sterno-mastoid muscle, which produces the same effect." Lesions of the axis affect the splenius usually producing contracture of it from which results impaired movement of the head and neck.

The **interspinales,** when affected and working together, produce impaction of the vertebræ.

The **levator anguli scapulæ,** when affected either draws upward the scapula or extends and laterally flexes the neck. Osteopathically it is of importance in that it is involved in most cases of "cold in the head" it being contractured and tender.

The **scalenus medius** arises from the upper surface of the first rib between the subclavian groove and tuberosity and is inserted in the posterior tubercles of the transverse processes of the lower six cervical vertebræ. It is the strongest of the scaleni muscles and has to with lifting the rib when the fixed point is above, or lateral flexion of the neck when the fixed point is below. Axis lesions impair its function, usually producing contracture of it. The most common effect is elevation of the posterior part of the first rib. (See lesion of first rib for effects.)

Axis lesions impair the above named muscles by **change of position.** The effects are, disturbance of **movements of neck,** spasmodic contraction or twitching, especially involvement of the **finer** movements of the head, torticollis, secondary lesions and disturbance of circulation of the spinal cord, cervical portion.

The **arteries** directly involved by an axis lesion are the vertebral and its branches, muscular and spinal. Those indirectly involved are the terminals of the vertebral and the carotid arteries and their branches. This involvement comes through their nerve supply, viz., vertebral plexus and superior cervical ganglion, which are affected by an axis lesion. The lesion produces pressure on the arteries in relation thereby lessening the amount of blood passing through them. The muscles in relation are improperly nourished, and the spinal cord is deprived of its normal arterial supply. Varied effects follow these conditions. (For effect on vertebral see arteries under atlas.)

The **veins** that would be affected by an axis lesion are those in relation. They are the **vertebral, lateral spinal** and **muscular,** which latter drain the muscles in that region. The vertebral drain the cervical spinal cord, cervical vertebræ and muscles. The lateral spinal drain the cord and empty into the vertebral. An axis lesion especially affects the size of the intervertebral foramina, usually lessening it. As a result the lateral spinal veins are compressed, venous congestion of the spinal cord follows which impairs its function, sometimes increas-

ing, sometimes decreasing activity, this depending on the degree of congestion, length of standing and function of part involved. The chronic effect is one of lessened activity. A certain amount of localized toxemia follows congestion. This may irritate the cells in the cord thus pro-

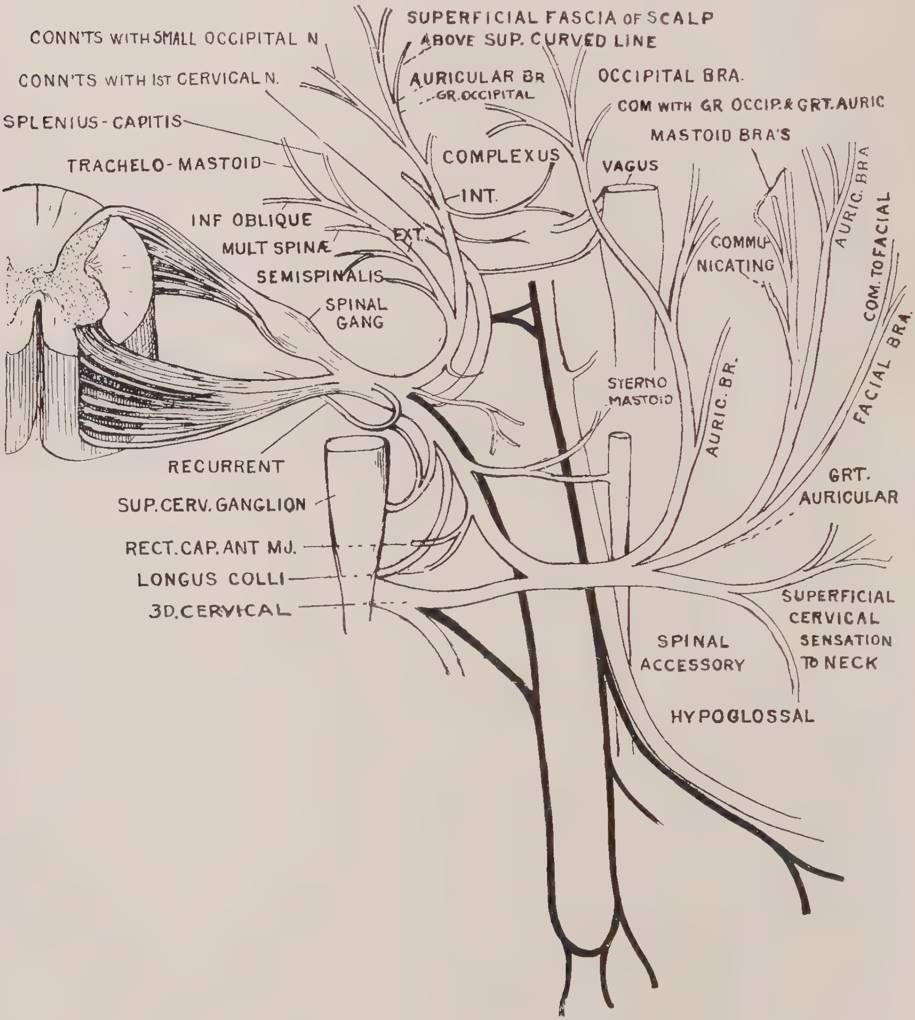

FIG. 17.—The second cervical segment showing its branches and connections.

ducing pain and muscular contracture. The lesion would also affect the vertebral. Since these veins drain the cord, vertebræ and muscles in relation, congestion of these parts follows a lesion of the axis.

The **nerves** involved by axis lesions are the second and third cervical nerves, recurrent meningeal, gangliated cord or superior cervical ganglion and vertebral plexus and their branches and connections. Indirectly all branches of these nerves may be affected by an axis lesion. Only the nerves in relation with the atlanto-axial articulation will be considered here.

The **second cervical** nerve, like those below it, divides immediately on its exit, into an anterior and posterior division. The posterior primary division in turn divides into a small external and large internal. The external supplies the muscles in relation. The internal is the **great occipital** nerve which is important in osteopathic therapeutics in that in headache in the back part of the head this nerve is supposed to be involved. It pierces the complexus and trapezius muscles after which it divides into terminal branches which ramify in the superficial fascia of the scalp as far as the posterior part of the parietal bones. Morris says that "occasionally one branch reaches the pinna and supplies the skin on the upper part of its inner aspect." It also communicates with the first and third cervical nerves. Pain in the area supplied by great occipital nerve must be in that nerve. Hilton says: "Suppose a patient to complain of pain upon the scalp, it is essential to know whether that pain is expressed by the fifth nerve or by the great or small occipital. Thus pain in the anterior and lateral parts of the head which are supplied by the fifth nerve, would suggest that the cause must be somewhere in the area of the distribution of the other portions of the fifth nerve. So, if the pain be expressed behind, the cause must assuredly be connected with the great or small occipital nerve, and in all probability depends on disease of the spine between the first and second cervical vertebræ." From our viewpoint this disease is a subluxation at this point and Hilton's idea bears out our practice.

The anterior division of the second cervical nerve, unites with the first, third and fourth to form the cervical plexus. The branches of this plexus that receive their impulses from the second cervical segment are the small occipital, great auricular, superficialis cervicis and muscular branches to the muscles in relation.

The **small occipital** follows the posterior border of the sterno-

mastoid muscle and gives off twigs to the skin over the upper portion of the triangular space. After perforating the deep fascia it reaches the scalp where it terminates in cutaneous filaments. It breaks up into three branches, the auricular, occipital and mastoid terminal branches.

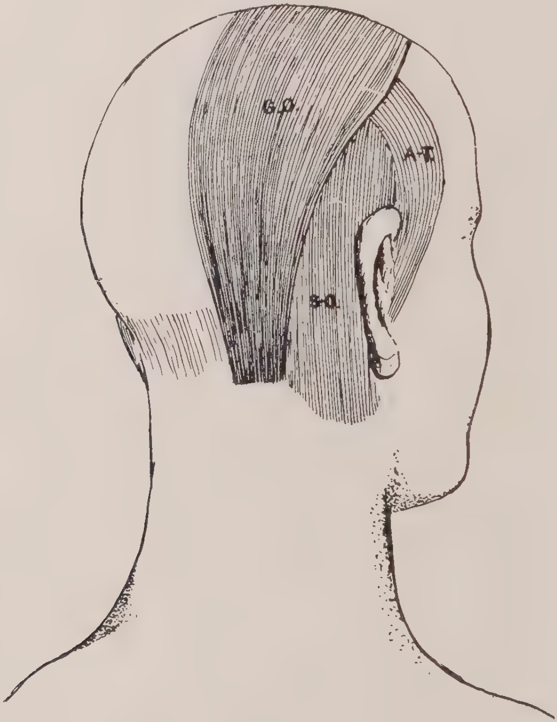

FIG. 17.—Showing sensory innervation of back of head (Hilton). G. O., great occipital; S. O., small occipital; A. T., auriculo-temporal. Headache from cervical lesions are referred in general, to these areas.

The auricular branch of the small occipital, is distributed to the skin of the scalp and communicates with the great occipital. The mastoid, is distributed to the skin over the mastoid process. The occipital branches ramify over the occipitalis muscle and supply the skin of the scalp. They communicate with the great occipital nerve.

In axis lesions the small occipital nerve is usually involved, hence

a sensory effect in the above named points of distribution of the nerve. Headache with tenderness of the scalp is very common when this nerve is involved.

The **great auricular** divides, in relation with the sterno-mastoid muscle, into three branches,—mastoid, auricular and facial. The mastoid supplies the integument covering the mastoid process, communicating with the mastoid branch of the small occipital. The auricular supplies the back and lower part of the pinna. The facial is distributed to that portion of the integument of the face over the parotid gland. Some filaments enter the gland and communicate with the lower division of the facial nerve. When this nerve is involved, as it often is in axis lesions, pain will be referred to the area supplied by the above named branches. Hilton cites a case of a "kernel" or enlarged gland lying close to the second nerve, causing earache. Muscular contracture will cause a similar effect.

The **superficial** or **transverse cervical** nerve has to do with supplying sensation to the integument of the lateral and anterior portions of the neck. It communicates peripherally with the cervical branch of the facial.

The **muscular** branches supply the sterno-mastoid, rectus capitus anticus major, longus colli, genio-hyoid, the infra-hyoid muscles, obliquus inferior, complexus, splenius and trachelo-mastoid muscles.

Axis lesions affect the **muscular** branches receiving impulses that pass out through the second cervical foramen, therefore these muscles would be affected, that is contracted or relaxed. The **sterno-mastoid** would thus be affected by an axis lesion. The most common effect is that of contracture producing torticollis. This muscle has its origin in the manubrium and clavicle and is directed up and back to the mastoid process and adjacent portion of occipital bone. It flexes laterally the head and neck, rotates the face to opposite side, and when acting conjointly with its fellow, raises the manubrium and clavicle or flexes head or neck. In torticollis from contracture of this muscle, the face is drawn toward the sound side. In some cases the disease is supposed to be congenital, but I think most of such cases occur at childbirth, for in such cases much traction, or rather improper traction, is exerted on the neck and a lesion of the axis is produced, which in turn affects the second nerve, hence this muscle. The **rectus capitus anticus major** has to do with slight flexion of the neck, hence this movement would be

abnormal in axis lesions. In some there is a fibrillary twitching as a result of irritation of this nerve.

The LONGUS COLLI has been considered above. The **genio-hyoid** muscle by contracting, draws the hyoid bone upwards and forwards or pulls the lower jaw downward. As a result of a lesion involving the nerve supply of this muscle, the hyoid bone would be drawn out of place, hence disturbances of the vocal organs. The **infra-hyoid** muscles, viz., STERNO-HYOID, OMO-HYOID, STERNO-THYROID and THYRO-HYOID, are supplied by the second cervical nerve by way of the loop joining the hypoglossal nerve. They, as their names indicate, are attached to the hyoid bone and by their unusual contraction or relaxation the bone assumes an abnormal position. As suggested above, the vocal organs would be involved since they are in relation with this bone. Aphonia is the most common effect.

The OBLIQUUS INFERIOR and SPLENIUS have been considered. See page 57.

The **complexus** is involved in axis lesions, thus interfering with extension and lateral flexion of the head and rotation of the face. In colds of the head this muscle is usually contractured.

The second cervical nerve connects with the ninth, tenth, eleventh and twelfth cranial nerves and the superior cervical ganglion. The vagus is reached by filaments to the lower ganglion or ganglion of the trunk, which is placed below the base of the skull.

The impulses passing over this nerve go from the superior cervical ganglion to the pneumogastric. On this account they are supposed to be vaso-motor and secretory in function. From a clinic point of view, it appears that motor impulses pass from the ganglion to the vagus since vomiting occasionally occurs from a lesion of the axis. In other cases seen by the author, asthma and violent attacks of coughing resulted from the lesion. This nerve filament is in relation with the atlanto-axoidean articulation and is affected in some lesions of this joint.

The eleventh unites in the sterno-mastoid muscle with the muscular branches of the second cervical supplying the sterno-mastoid.

This nerve is affected by an axis lesion both along its course and at its spinal origin. Contracture of the sterno-mastoid muscle will cause it to be impinged on. The spinal portion arises as low in the spinal cord as the fifth cervical segment. The filaments pass out or the lateral column of the white matter of the spinal cord and forming a few strands,

pass upwards through the foramen magnum into the cranial cavity. As soon as it leaves the skull, it communicates with the vagus, and its accessory fibers continue into the recurrent laryngeal, cardiac, pharyngeal and superior laryngeal branches.

The axis lesion interferes with the nutrition of the spinal segments in which are located the cells of origin of the spinal portion of this nerve, hence the effects on its function. This interference is the result of circulatory derangements of the supply and drainage of this segment.

The **hypoglossal** nerve receives fibers from the first and second cervical nerves that supplý the infra-hyoid muscles. The spinal origin of the nerves of these muscles has been proven by experiments on animals.

The superior cervical ganglion communicates with the second cervical nerve by means of a grey ramus uniting with the anterior division.

The **ninth** cranial, connects with the superior cervical ganglion by a fine communicating filament. This nerve filament is supposed to carry vaso-motor impulses from the ganglion to the nerve, hence to parts supplied by the nerve viz., the pharynx, tonsils and tongue.

To summarize the effects on the second cervical nerve, there would be pain in the back of the head, ear, parotid gland and part of face, that is headache, earache and neuralgia; torticollis, chorea and various other disturbances of the cervical muscles; aphonia, and other impairments of the voice; various secondary effects on the tenth, eleventh and twelfth cranial nerves and structures supplied by them; also some effect on the superior cervical ganglion.

The **recurrent meningeal** would be affected in a way similar to that in atlas lesions.

The **second cervical segment** would probably be directly affected by this lesion. Vascular disturbances of the cord, meninges, ligaments and column are the important effects of disturbance of the recurrent nerve. The effects and diseases caused by the superior cervical ganglion have been considered (see p. 31.) This ganglion being in relation with the axis is more easily and more commonly affected by an axis than by an atlas lesion.

The vertebral plexus surrounds the vertebral artery and is more or less affected by the lesion. This plexus sends filaments over the lateral spinal arteries into the cord. The blood supply of the cord, perhaps the second segment more than any other, would be affected by

disturbance here of the vertebral plexus. The meninges are affected in all marked lesions. A part of the coverings of the cord passes out with each nerve and is attached to the vertebræ, hence would be affected by every abnormal change of position. These coverings are also affected through the blood and nerve supply. Meningitis and other disturbances follow such lesions. The spinal cord is affected through its blood supply or by direct pressure, in which case there is usually paralysis of the parts below, resulting in death. Arterial supply to and drainage of the cord are impaired and, as mentioned above, the cells in the various centers fail to properly perform their function.

Summary. The axis is the most frequently subluxated of all the vertebræ, at least the atlanto-axoidean articulation is oftenest affected. This comes from the free mobility of this joint and lever action of parts above. The articular processes of the axis can be more readily palpated than those of the other cervical vertebræ, they being best felt at a point about midway between the spinous and transverse processes. A strain of the ligaments will cause a thickening, which irregularity may be mistaken for a bony lesion. A unilateral thickening or lump over the articular process is indicative, if not diagnostic, of a strain of the ligaments. This is quite often but not always accompanied by a subluxation. This explains why in many cases in which faithful and persistent work has been given the irregularity, the lump or thickening, remains and the articulation continues to be tender. Strained ligaments heal slowly.

An axis lesion may produce almost any form of disease in organs and tissues above it. The diseases most commonly associated with axis lesions are eye affections, headaches and vascular disturbances of the head.

The **vaso-motor** effects of this lesion are similar to those of an atlas lesion and are explained in a similar way. In addition it might be stated here that some of the vaso-motor effects in parts supplied by the ninth, tenth and twelfth cranial nerves, are the results of this lesion affecting the superior cervical ganglion and its branches of communication to these nerves over which the impulses pass.

The motor effects are most marked in the cervical muscles, the throat and hyoid muscles and the involuntary muscle fibers of the eye. The secretory, are the same as for an atlas lesion. The sensory and trophic effects are best explained through the vaso-motor connections.

THIRD CERVICAL.

The **third cervical vertebra** is the smallest of the vertebræ. The laminæ are especially light, thus permitting of fracture which occurs oftenest in this vertebra. It is located farther anterior than the other cervical vertebræ, partly on which account this region is weak. McClellan says: "The weakest point, not only in the neck but also in the entire spinal column, is between the second and third cervical vertebræ." The Superior Facets of the third cervical face upward and backward, are slightly concave and somewhat smaller than the corresponding ones of the atlas and axis. The shape of the superior facets would permit of almost any form of movement, but antero-posterior motion as in nodding the head, is most pronounced. The spinous process is shortest of all the vertebral spinous processes and can, in the the normal neck, be felt with difficulty unless flexion is used. If it cannot be palpated when the neck is flexed, or if it can be palpated without flexion of the neck, it is ordinarily regarded as abnormal, especially so if tenderness is present over the spine or articular process. This shortness permits of freer movements. The transverse processes are perforated for passage of the vertebral arteries as are those of the axis, but are not so well developed as those below, yet are usually longer than those of the axis.

This bone and its articulations are subject to displacement and injury as are all vertebræ and their articulations. The most common lesions are an anterior or posterior subluxation, or torsion. This vertebra is possibly dislocated as an individual bone, more often than any other cervical vertebra. Usually, in a "lesion" one part of the spinal column is moved on another, hence only two articular facets are involved and it is not so common for both the superior and inferior facets to be involved as would be the case in a subluxation of a single vertebra. The exception seems to be in the third cervical vertebra, since its most common subluxation is one in which it is forced either forward or backward, that is, both superior and inferior facets are involved. The diagnosis is based on irregularity, tenderness and disturbance of motion. In making tests for weak places or lesions in the spine in general, Dr. G. D. Hulett advised extreme flexion. In this test there will be pain at the weakest points. This can with advantage be used in cases of suspected lesions of the neck.

The **intervertebral discs** in the cervical region are not very thick but are thicker anteriorly than they are posteriorly. The curve of the neck depends on this rather than on the size of the bodies of the vertebræ. Curvatures in the cervical as well as in other regions, are partly the result of changes in thickness in the intervertebral discs. These discs are elastic, have blood-vessels and nerves, and their function is impaired by bony lesions of the corresponding vertebræ, and as they become thinned, the foramina become smaller.

The effect of a lesion of the third cervical on the ligaments is similar to that of an axis lesion, that is they become as a rule thicker, and tender, which conditions can best be ascertained by palpation over the articular facets. The ligaments attaching the third cervical vertebra to the axis and fourth, are the regular spinal ligaments while the atlas and axis have, on account of the extra strain, special ligaments to reinforce the common spinal. The ligaments common to all the vertebræ are the intervertebral discs, anterior common, posterior common, ligamenta subflava, capsular, supraspinous, interspinous, and intertransverse. These ligaments quite securely bind the vertebræ together, limit the movements of the individual vertebræ, and assist in the protection of the spinal cord and its nerves branching from it. They are to a certain extent elastic and are subject to contraction and relaxation since they have both blood-vessels and nerves. No detailed description of the ligaments common to the spinal column is deemed necessary, but attention is called to the intervertebral discs, the capsular and supraspinous ligaments. The supraspinous ligament, or ligamentum nuchæ, in chronic lesions is usually so much thickened that it can be readily palpated by pressure directed against the spinous process. The best sign of chronic lesions, especially in the thoracic and lumbar regions, is a softening and thickening of the supraspinous ligament. In most cases these changes are followed or accompanied by a shortening, hence approximation of the vertebræ. This in turn thins the discs, lessens the size of the foramina and changes the contour of that part of the spinal column.

The principal **muscles** of importance attached to the third are the anterior and middle scaleni, rectus capitus anticus major, longus colli, levator anguli scapulæ, splenius, transversalis colli and multifidus spinæ. All but the scalenus anticus and transversalis colli muscles have been discussed. (See page 57.) The scalenus anticus arises from the an-

terior portion of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ and is inserted into the tubercle on the upper border of the first rib anterior to the groove for the subclavian artery. It is of interest in that the first rib is drawn upward against the clavicle when this muscle is in a contractured condition, which is often the case when the vertebræ to which it is attached are displaced or its nerve supply affected. As a result there is trouble from pressure on structures by the displaced rib and from disturbance of the sympathetic gangliated cord, since the first dorsal and last cervical ganglia are located on the head of the rib.

The **arteries** involved in lesion of the third cervical vertebra are the vertebral and its lateral spinal and muscular branches. The effect here is similar to, if not identical with, that outlined under the axis.

The third cervical segment would probably suffer more than other segments, if the lateral spinal branch passing through the third cervical foramen were disturbed. This artery, like those from below, passes up the sheath of dura mater which envelops the roots of the spinal nerves. A lesion of the third cervical vertebra would cause contraction of many of the muscles supplied with blood by the muscular branches of the vertebral. As a result, circulation through the vertebral and its other branches would be impaired. This means a vascular disturbance of the cervical spinal cord and perhaps medulla and brain with many possible effects ranging from a "cold in the head" to meningitis.

The **veins** involved are the vertebral and its spinal and muscular tributaries. From this involvement comes congestion of the spinal cord and the neck muscles in relation, which is accompanied by various symptoms, they depending on the centers involved.

The **nerves** involved by a lesion of the third are the **third** and **fourth** cervical nerves (only the third will be considered here) and their branches and communications the **superior cervical ganglion, vertebral plexus,** and the **recurrent meningeal.**

The third cervical **segment** gives origin to the following nerves, all of which pass out of the foramen in relation with the articulation of the axis and the third; SMALL OCCIPITAL, GREAT AURICULAR, SUPERFICIAL CERVICAL, SUPRA-CLAVICULAR, branch of communication to the hypoglossal, THIRD, OR SMALLEST OCCIPITAL, MUSCULAR branches, and usually a root of the phrenic.

The **small occipital** has been considered along with the great auricu-

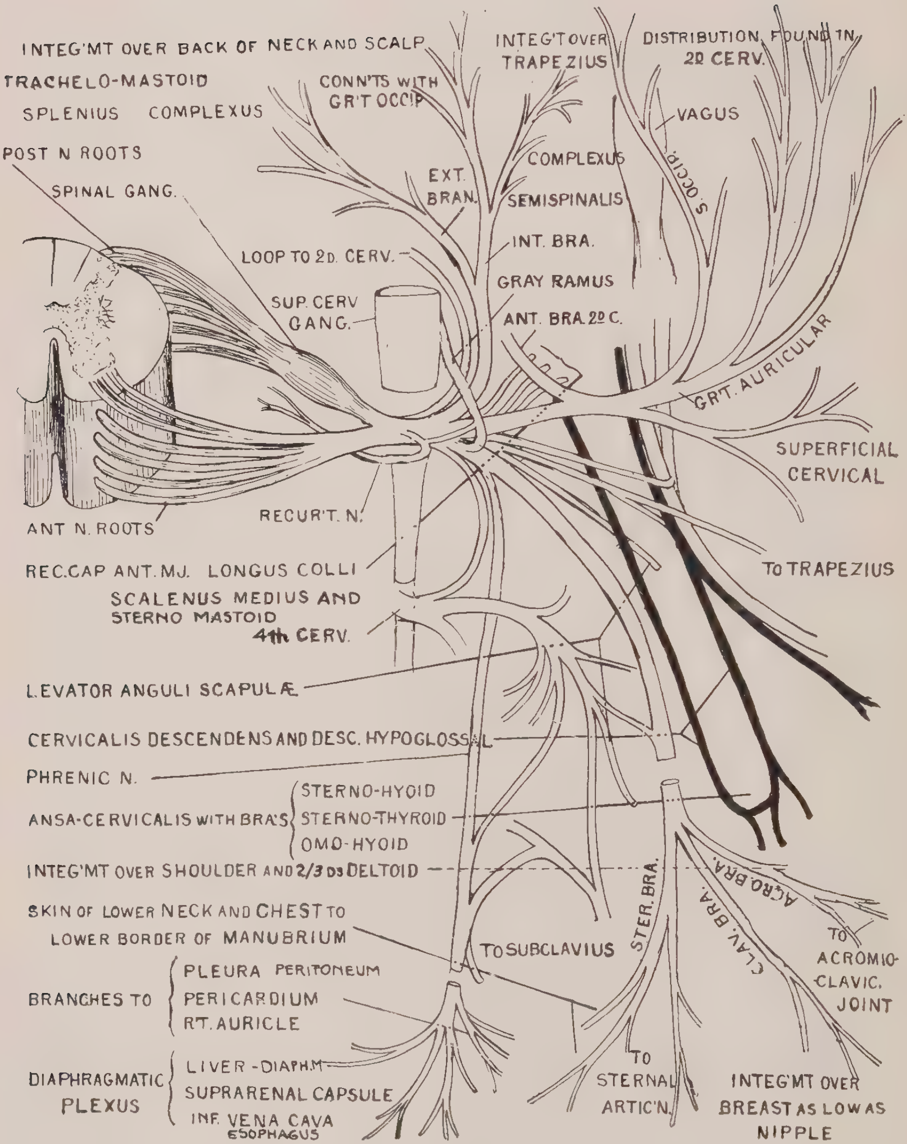

FIG. 19.—The third cervical segment showing its branches and connections.

lar, and superficial cervical as well as some of the muscular branches. The effect on the above named nerves from a lesion of the third cervical is very similar to, if not identical with, that from an axis lesion. An additional point regarding the superficialis colli nerve might be indicated here. Deaver says that the ascending branch "sends filaments to the external jugular vein, communicates with the inframaxillary branch of the facial nerve, and supplies the platysma myoides muscle and the skin of the front of the neck as far as the chin." This is of value since certain forms of jerking of the head or chorea are due to spasmodic contraction of the platysma myoides. Such spasmodic contractions result from an interference with the nerves supplying it, this interference in many cases resulting from a subluxation of the axis or third cervical.

The **supraclavicular** or descending branch of the cervical plexus come almost entirely from the third cervical segment. This nerve divides into an internal, middle and external or posterior branch. The internal or suprasternal ramifies over and below the inner third of the clavicle and terminates over the upper part of the sternum. Some filaments are furnished to the sterno-clavicular articulation (Rudinger).

The **middle** or **supra-clavicular,** supplies the integument over the forepart of the deltoid and the pectoral muscles as low as the third rib and over the upper part of the mammary gland as low as the nipple. These filaments communicate with the small lateral cutaneous branches of the upper intercostal nerves.

The **external** branches innervate the integument over the acromion and outer and back part of the shoulder, and above the spine of the scapula. In conditions of pain, if cutaneous, in the above areas, this nerve is usually involved. Contractures in the neck, and lesions of the axis or third, readily affect this nerve which is manifest by sensory disturbances in the above mentioned areas.

Deaver says: "Herpetic eruptions in the area of distribution of the superficial branches of the cervical plexus (herpes cervico-occipitalis) are occasionally seen. In caries of the cervical vertebræ, pain may be referred to the areas of the skin supplied by these nerves. It is through the descending branches of the cervical plexus that pain is referred to the neck in carcinoma of the mammary gland." Lesions of the third cervical vertebra cause pain in the area of distribution of the supra-clavicular nerve because it is in relation with the articulation

and is irritated or otherwise affected by the subluxation.

The **third** or **smallest occipital** nerve, the inner branch of the posterior division of the third cervical nerve, supplies the skin of the upper part of the back of the neck, and part of the scalp in the region of the external occipital protuberance. This nerve is involved in pain in the back of the neck, coldness of the part and in boils and carbuncles which so frequently attack the back of the neck on account of the great thickness of the integument. If a lesion of the axis or third cervical vertebra exists, the back of the neck is cold a great deal of the time. Coldness of this part of the neck is accompanied or followed by nasal catarrh or "sore throat." If the back of the neck is always kept warm, I seriously doubt the possibility of one "catching cold" in the head and throat. Lesions of the third affect the third occipital, and since it is distributed to the back of the neck, this region is in all probability affected, with the above predisposition to nasal catarrh.

The **muscular** branches coming from the third cervical segment supply, at least in part, the following muscles: Rectus capitus anticus major, longus colli, trapezius, levator anguli scapulæ, sterno-mastoid, diaphragm, intertransversales, multifidus spinæ, complexus, splenius and the infra-hyoid muscles. All of the above named muscles except the trapezius and diaphragm have been considered. The usual effect on these muscles is that of producing a contractured condition which, if unilateral, produces a muscular curvature, but if symmetrical, draws the vertebræ more closely together thus lessening the size of the intervertebral foramina.

The **trapezius**, one of the superficial muscles of the back, is of osteopathic interest in that it is always tender in cases of **cold in the head;** the more severe the attack the more tender the muscle. This area of tenderness in colds corresponds to the distribution of the two trapezii muscles. By contraction, it draws the head back, flexes the neck toward the same side and turns the face to the opposite side. If the muscle is in a contractured state, these movements are impaired, the circulation through the muscle impeded, the circulation to the spinal cord affected and the sympathetic gangliated cord deranged, as is evidenced by the vaso-motor changes accompanying and following its contracture. The diaphragm will be considered in the discussion of lesions of the fourth cervical vertebra (see page 78).

The nerve communicating with the hypoglossal nerve is frequently

involved by a lesion of the third as a result of which the hyoid muscles are affected and from this, disturbances of the voice box. The **phrenic** is also involved by this lesion, the effects of which are discussed with that of effects on nerves in lesions of the fourth cervical vertebra.

The **superior cervical ganglion** is sometimes affected by this lesion but not so frequently as by lesions of vertebræ above. For effects see page 29.

The **recurrent meningeal,** which enters the spinal canal, is nearly always affected by the lesion as a result of which, various pathological changes take place in the structures innervated by it, viz., the spinal cord, meninges, vertebræ and ligaments. The vertebral plexus is also involved, the effect being similar to that from an atlas or axis lesion. The most important effect is that on the eye. According to Deaver, contraction of the pupil on the same side follows ligation of the vertebral artery. Probably the effect is through the vertebral plexus of nerves rather than through the artery. If a ligature will produce an effect, lesions of the cervical vertebral articulations will also in some way affect the eye. At least the connection between the neck and the eye is proven.

Lesions of the axis and third affect the vertebral artery and its accompanying nervous plexus, hence an effect on the eye.

The third cervical segment contains several centers of importance. Motor centers are located here which control the amount of nerve force to and nutrition of the muscles supplied by the third cervical nerve. These have been named above. Sensation to the back of the head and possibly the face or areas supplied by the fifth cranial are influenced by this segment. The explanation is that one of the sensory roots, the descending or long root, has been traced to the floor of the fourth ventricle and to the grey matter in the lower part of the medulla oblongata and as low in the spinal cord as the third cervical segment.

The **spinal accessory** nerve which is supposed to take the place of the white rami in the cervical region, is affected by this lesion on account of its spinal origin. Most of the vaso-motor, motor, and visceromotor impulses passing out over the spinal accessory reach the pneumogastric and are distributed with its branches. The spinal origin of the eleventh cranial nerve is as low in the spinal cord as the seventh cervical segment. On this account, its cells of origin are affected by cervical lesions through interference with nutrition.

A lesion of the third cervical vertebra will affect the various nerve

filaments connecting the superior cervical ganglion, ninth, tenth, eleventh and twelfth cranial, and the upper cervical nerves.

A small filament connects the superior cervical ganglion with the ninth. It is supposed to be vaso-motor in function, that is, the vaso-motor impulses passing over the ninth are derived, at least in part, from the superior cervical ganglion by way of this communicating branch. As a result of the lesion there will be vaso-motor disturbances in the parts supplied by the glosso-pharyngeal nerve viz., the tonsils, tongue, and throat.

There are several nerve strands that connect the tenth cranial and the superior cervical ganglion. They pass to both ganglia of the nerve, the ganglion of the trunk and the ganglion of the root. They are vaso-motor in function and furnish the vagus with some if not a majority of its vaso-motor impulses.

The hypoglossal receives vaso-motor impulses from the superior cervical ganglion by way of a filament directly connecting the two. Langley says in connection with this nerve: "The peripheral part of the hypoglossal nerve has a slight vaso-constrictor action on the arteries of the tongue. The vaso-constrictor fibres come in part, at any rate, from the superior cervical ganglion. It has been supposed that some issue with the roots of the hypoglossal nerve but the evidence is not satisfactory."

Clinically it seems without doubt that the vaso-motor impulses of the hypoglossal nerve are derived by way of the superior cervical ganglion judging from the vaso-motor effects of a cervical lesion on the parts supplied by the twelfth nerve.

Grey rami communicantes connect the superior cervical ganglion and the upper four spinal nerves. Those branches to the third and fourth, according to Quain, often pierce the rectus capitis posticus major muscle. Contracture of this muscle from a lesion of the third cervical, would interrupt this connection and lead to disturbances of function. "Some of these fibres pass peripherally, some centrally." Of those passing centrally "some follow the posterior primary division of the nerve, others enter the sheath of the nerve, the surrounding tissue in the intervertebral foramen, and the dura mater, running up the latter in the posterior root." Quain further says: "The fibres passing distally in the anterior and posterior primary divisions of the nerves have been shown by experiments on animals, to supply vaso-motor nerves

to the arteries of the body wall and limbs, pilo-motor fibres to the muscles of the hairs and secretory fibres to the sweat glands." A lesion of the third cervical vertebra will interfere with this connection, because the grey rami are in relation with the articulations of this vertebra.

The external branch of the **spinal accessory,** according to Landois, "anastomoses with sensory filaments from the posterior root of the first, less commonly also of the second cervical nerve, which supply muscle-sense fibers to it." It then supplies the sterno-mastoid and trapezius muscles. Landois says further that the external branch anastomoses also with several cervical nerves. "Either these fibres take part in the innervation of the muscles named, or the accessory returns to them, in part, the sensory filaments received from the posterior roots of the two uppermost cervical nerves, which then constitute the cutaneous branches of these cervical nerves."

The filament connecting the upper cervical nerves with the hypoglossal nerve, carries motor and vaso-motor impulses to it, thus supplying the hyoid muscles, and tongue.

The function of the fibres connecting the **vagus** and the upper cervical nerves is unknown. Judging from clinical indications, it is probably sensory. The writer has known of cases in which pressure exerted at the second cervical vertebra would produce nausea and vomiting. Possibly the impulses were transmitted by these connecting filaments.

The **ninth** nerve is directly connected with the jugular ganglion of the vagus but according to Landois, the function of this branch is unknown.

He says in connection with the branches uniting the pneumogastric and spinal accessory nerves that the "entire inner half of the accessory nerve enters the trunk of the vagus. This transmits to the latter, motor fibers for the larynx (through the recurrent branch of the vagus), for the pharynx and the cervical portion of the esophagus and the stomach (?), as well as the cardiac inhibitory fibres."

Some of these functions seem to be doubtful, since he marks them as inconstant or uncertain.

The function of the filament connecting the vagus and the hypoglossal nerve is unknown.

The above statements concerning the effects on these communicating branches will apply equally well to lesions of the atlas and axis.

Some writers attribute vaso-motor functions to the third cervical nerve that are independent of the superior cervical ganglion but Langley seems to doubt such statements.

Summary of the third cervical vertebra. It is the most fragile vertebra hence most easily broken; its articulations are quite freely movable, thus lesions are common. As a result of a lesion of this bone, certain disturbances fairly constant, are found, such as eye troubles, especially weakness and impairment of vision. I have reference in the above, to tendency to formation of tears on exposure to wind and photophobia if light is strong. In addition, there results headache (occipital), roaring in the ear, and what some call a "beefy" neck which is characterized by increase in amount of connective tissue which gives it a soft, bulky feeling. There may be disease of any part of the head and face as a result of lesion of this vertebra, but the eye is most frequently affected of all parts.

THE FOURTH CERVICAL.

The **fourth cervical** vertebra has few if any peculiarities, it being a typical vertebra. In size it is slightly larger than the third, the spinous process is longer, the transverse processes slightly larger, while in most cases it is not located so far anteriorly as the third. The superior facets face upwards, backwards and inwards, are slightly concave and permit of slight movement in all directions, perhaps the antero-posterior movement being the most marked.

This vertebra is subject to lesions similar in character to those of other vertebræ, a torsion or lateral deviation being most common.

These lesions are characterized principally by a thickening of the ligaments in relation with the articular processes. The ligamenta subflava and the capsular are usually the ligaments most affected. By careful and deep palpation over the articular processes, that is at a point about midway between the spinous and articular processes, these thickened and tender ligaments can be distinctly felt thus furnishing one of the most reliable of signs of a cervical vertebral lesion. In cases in which the lesion was produced by trauma, these ligamentous changes are particularly noticeable.

In lesions of this bone the movements of the neck are impaired, since its articulations are involved in the various movements of the head and neck. As a result of a traumatic lesion the ligaments attaching this bone to the adjacent vertebræ are stretched, torn or otherwise affected, this depending on the degree of lesion. This change in the ligaments makes free movement of the head difficult, lessens the size of the foramina and weakens this portion of the spinal column. In other cases

relaxation of the ligaments takes place, thus permitting too free mobility, and in marked cases the patient is unable to hold the head erect. The discs are also stretched, torn or abnormally compressed, which changes affect the normal curvature of the neck, thus laying the foundation for spinal curvature of the cervical region.

The principal **muscles** attached to the fourth cervical vertebra and which would necessarily be affected in some way in lesions of it, are the following: Scalenus anticus, scalenus medius, rectus capitis anticus major, longus colli, multifidus spinæ, semispinalis colli, complexus, cervicalis ascendens and splenius. The effect on these muscles is most frequently that of contracture. The other attachments of these muscles are drawn nearer the fourth or else it is drawn closer to them, that is the cervical spinal column is drawn out of line. In either case there would be a warping of the framework of the body, for muscles are generally attached to bones and are always shortened when contractured.

The **arteries** and **veins** correspond to those of the third and would be affected similarly, the effects being about the same. The spinal cord suffers most when these vessels are impinged.

The **nerves** having their origin in the fourth cervical segment and passing out through the fourth cervical foramina are the posterior division of the fourth, the supra-clavicular, muscular and phrenic.

There are various other nerves and connecting filaments in relation with this vertebra, and would, in all probability, be affected by the lesion. They are, the recurrent meningeal, vertebral plexus, sympathetic gangliated cord, and the filaments connecting the superior cervical ganglion with the upper cervical and the cranial nerves. On account of the relation of the parts thus connected, these filaments are in relation with the articulations of the fourth, and would be impaired by the lesion. As to the functions of these nerve fibers see effects on nerves of a lesion of third cervical.

The supraclavicular nerve and its distribution have been discussed (see third cervical). The muscular branches supply the following: RECTUS CAPITUS ANTICUS MAJOR, LONGUS COLLI, SCALENUS MEDIUS, SCALENUS ANTICUS, DIAPHRAGM, LEVATOR ANGULI SCAPULÆ, TRAPEZIUS, COMPLEXUS, SPLENIUS, MULTIFIDUS SPINÆ, SEMI-SPINALIS COLLI and INTERSPINALES. All of these have been considered with the exception of the diaphragm which will be considered here, since its innervation is almost entirely from the fourth cervical segment.

The **diaphragm** is a dome-shaped, thin muscular sheet which separates the thoracic and abdominal cavities, forming the floor of the former and roof of the latter. Its construction is peculiar in that it consists of "muscular and tendinous portions which arise by numerous digitations and, arching upward and inward, converge to be inserted into a common central tendon." It is attached above to the pericardium which serves to maintain its arched position during respiration. It arises from the lower six or seven ribs, the internal surface of the ensiform cartilage, the bodies of the lumbar vertebræ and the tendinous arches over the quadratus lumborum and psoas muscles which are called, from their shape and ligamentous character, the ligamenta arcuata externa and interna. The external extends from the twelfth rib to the transverse process of the first lumbar vertebra. The attachments to the bodies of the lumbar vertebræ are known as the crura of the diaphragm. Their fibers in passing upwards are so placed that they cross each other in such a way that they form a figure-of-eight arrangement around the various openings of the diaphragm. The fibers converge for insertion into the central tendon.

In applying this knowledge of origin and insertion it can be seen that displacement of the lower ribs or lumbar vertebræ will affect the muscle and change the size of the openings in it. From its position and relations, enlargement of the viscera in relation embarasses its action, as is evidenced by shortness of breath after a full meal.

There are various **openings** through which pass important structures. The **aortic** is between the crura and gives passage to the aorta, thoracic duct and the vena azygos major. The **esophageal** opening transmits the esophagus and the pneumogastric nerves and esophageal branches of the thoracic aorta. The opening for the **inferior vena cava** gives passage to the inferior vena cava, a branch of the right phrenic nerve and to some ascending lymphatic vessels from the liver. The sympathetic chain and the greater and lesser splanchnics of the right side pass through the right crus. The openings in the left crus transmit the greater and lesser splanchnics of the left side and the vena azygos minor. These openings are affected in displacement of the muscle. Lesions of the lower ribs displace the diaphragm. The aorta is obstructed thus throwing more work on the heart, possibly causing regurgitation. The veins are obstructed which causes congestion of parts drained by

them. The nerves are involved, hence disturbances in viscera innervated by them.

The **nerve** supply of the diaphragm comes principally from the phrenic and the lower five or six intercostals. The diaphragmatic plexus, which is formed by offsets from the upper part of the solar plexus which ramify with the phrenic, reinforce the above named nerves to the muscle. At the point where this plexus joins the phrenic nerve is a small ganglion called the **ganglion diaphragmaticum,** which sends filaments to the liver, inferior vena cava and the suprarenal capsule. Lesions of the fourth cervical, lower ribs and lower thoracic vertebræ will affect the innervation of the diaphragm, hence impair its action.

The **action** of the diaphragm is to deepen the chest. It is a powerful muscle of inspiration. It acts in conjunction with the abdominal muscles in acts requiring an increase in the intra-abdominal pressure, such as defecation, micturition, parturition, coughing, sneezing, vomiting, etc. Its most important function is that of assisting in respiration. Hilton calls attention to the action of the diaphragm on the liver. By its contraction the liver is compressed, thereby assisting the circulation of the blood through it. Exercise causes an increase in the frequency and intensity of contraction of the diaphragm, hence is good for a torpid liver. Enforced rest often causes jaundice.

The distribution of the phrenic to the diaphragm is an unusual one. It pierces the muscle and is distributed to the under surface, probably for the sake of protection since in respiration, pressure is strongest against the upper surface of the muscle. In abnormal distension of the stomach, the nerves to the diaphragm are compressed or otherwise affected and hiccough results. Gravity tends to prevent pressure of viscera on this muscle by drawing the liver and stomach down.

The phrenic has other functions than that of supplying motion to the diaphragm. It supplies in addition, the pericardium, pleura, sends a few filaments to the peritoneum and on the right side, the inferior vena cava and the right auricle of the heart. It helps to form the ganglion diaphragmaticum which sends branches to the supra-renal capsule, hepatic plexus and the inferior vena cava. Lesions of the middle cervical vertebræ affect this nerve, hence would affect the above named structures and organs which it directly or indirectly supplies. The diaphragm is its most important distribution.

The most common effect of a lesion of the fourth cervical on this muscle is a spasmodic contraction, or **hiccough.** In some cases paralysis of this muscle follows a neck lesion. The writer has examined cases in which respiration was carried on apparently by the thoracic muscles, the phrenic being partly or wholly paralyzed as a result of a cervical lesion. The respiration in such cases is usually sighing and irregular. In asthma the opposite condition exists, that is, the thoracic muscles perform a very small part in respiration, it being carried on almost exclusively by the diaphragm and abdominal muscles.

Experimentally, section of both these nerves, is followed by paralysis of the diaphragm. Death soon follows because of the inability of the thoracic muscles to carry on respiration since the diaphragm becomes so relaxed that it no longer furnishes a fixed point or fulcrum from which the other muscles of respiration can act. On account of this, the air already in the lung cannot be expelled neither can a partial vacuum be formed by which air is drawn into the lungs. Section of only one phrenic, is often followed by pneumonia according to McLachlin. A lesion may so impair the action of this nerve that it will have a tendency to the production of pneumonia. A lesion of the fourth may have either an inhibitor, or a irritative effect. On this account, the lesion can be substituted for the means commonly used in experiments and the results will compare favorably if the difference in amount of stimulation or inhibition used, is considered.

Usually in neck lesions some form of respiratory disorder complicates on account of the effect on the phrenic nerve. This disturbance may be a labored respiration, Cheyne-Stokes respiration, sighing, spasmodic or irregular breathing. In treating such effects it does little good to press on, or otherwise affect the trunk of this nerve, except in cases in which only a palliative or temporary effect is wanted or a curative one can not be obtained. In **hiccough,** this nerve should be examined from origin to destination and especially at its spinal origin and exit and the points of its distribution. The first has been considered. The second part is as important since fatal attacks result from a diseased liver pressing on the nerve on the under surface of the diaphragm, from displacement of the lower ribs and the lumbar vertebræ and from enlargement or displacement of the viscera in relation with the under surface of the muscle.

The more obscure effects of a lesion involving the phrenic nerve are

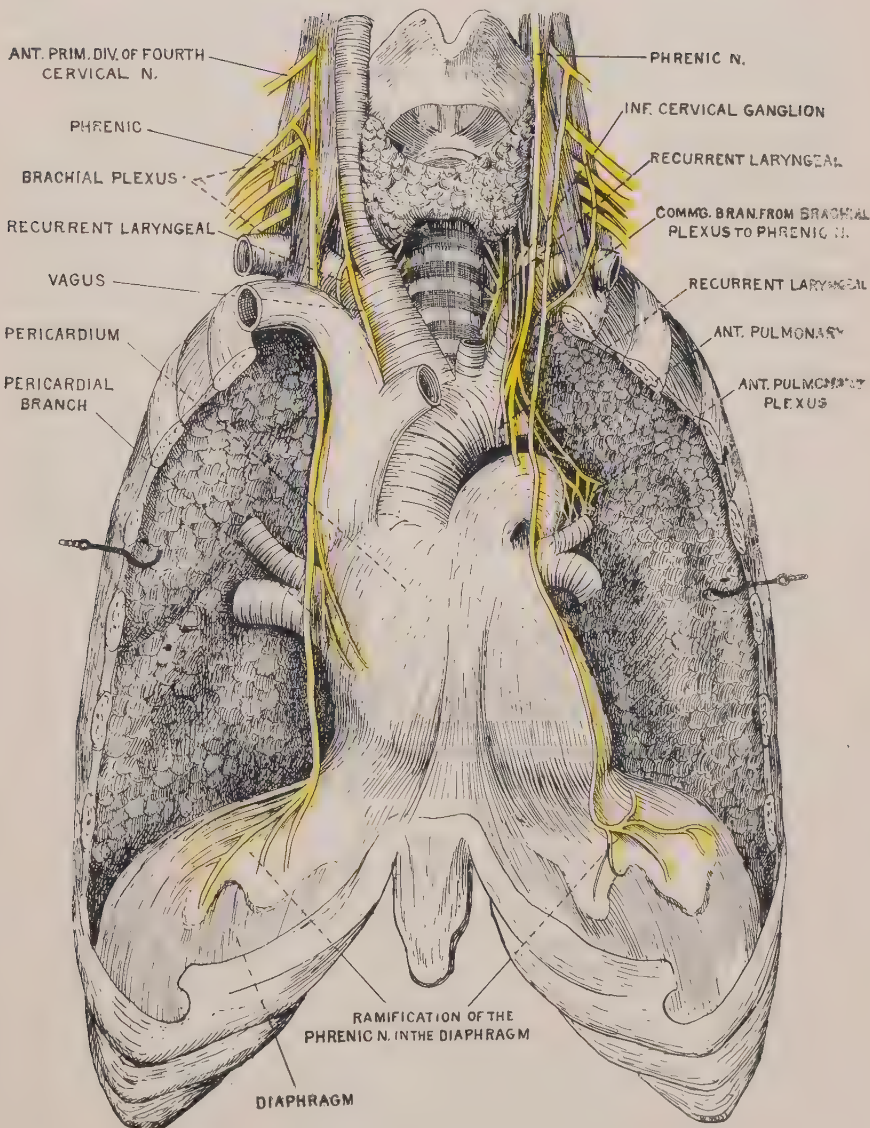

FIG. 20.—Showing course and distribution of the phrenic nerve.

those on the pericardium, pleura, heart and supra-renal capsule. It is supposed to be a sensory nerve to these parts, in which case pain in these structures supplied is at least partly the result of disturbance of this nerve. As to the effects on the abdominal viscera and structures to which it is distributed, one can only conjecture. Since it indirectly supplies the supra-renal capsule, peritoneum, liver and the inferior vena cava, it is fair to assume that disturbances in these organs and structures come in part or wholly from an impairment of the phrenic nerve, and since a lesion of the fourth cervical will affect this nerve the conclusion is evident. The phrenic receives a direct twig of communication from the inferior cervical ganglion and in most cases a branch from the plexus subclavius. This explains the relation of a lesion of the first rib and its effect on the phrenic. A dry hacking cough is sometimes the result of disturbance of the phrenic. I would suggest a lesion of the first rib as the cause in most cases.

The posterior division of the fourth cervical nerve, dividing into the usual internal and external branches, supplies sensation to the integument over the lower part of the neck. The recurrent meningeal, vertebral plexus and superior cervical ganglion are affected in typical cases. These effects are similar to those from an axis lesion, which see. The fourth cervical segment is also involved, the lesion disturbing the circulation to it, especially interfering with its drainage.

This segment contains very important centers, those for the phrenic being the most important. The predominate respiratory center is supposed to be in the bulb, with subsidiary centers in the spinal cord. In either case impulses pass through the fourth cervical segment to the phrenic.

Summary of fourth cervical. Lesions of this bone are most frequently an antero-posterior displacement or a torsion.

The **motor** effects of this lesion are contracture or relaxation of the muscles supplied by the fourth cervical segment. In the case of the diaphragm, there would be, on stimulation, a clonic contraction or hiccough. If the lesion is inhibitory, relaxation would be the result. The **sensory** effects are characterized by pain, or anesthesia or numbness of the integument over the lower part of the back of the neck, the upper part of chest and over top of shoulder, and possibly in the parts supplied by the phrenic nerve.

The **vaso-motor** effects depend on effect on the superior cervical

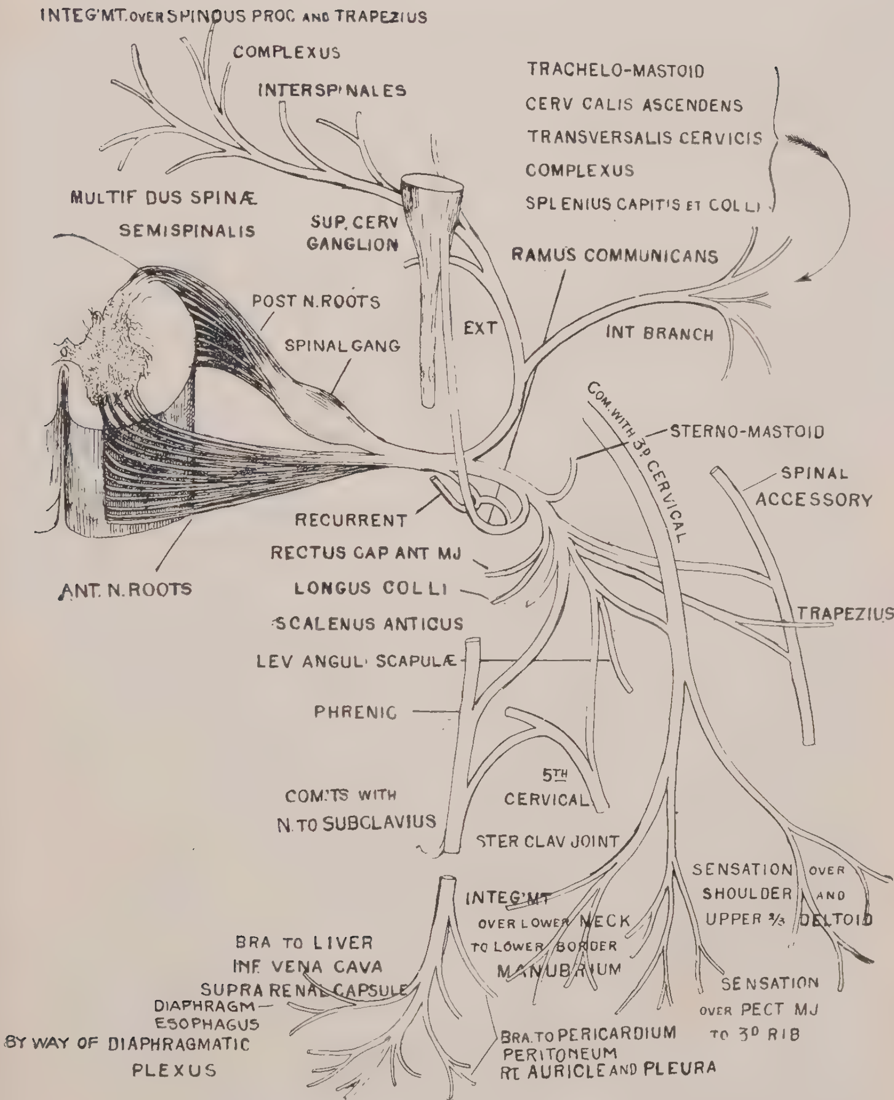

FIG. 21.—Showing the fourth cervical segment of the spinal cord and its nerves with their distribution.

ganglion, the grey rami and the recurrent meningeal nerves. Any structure supplied by the above nerves is apt to be affected by a lesion of the fourth cervical vertebra, since the nerves are in relation.

The secretion of sweat of parts above may be disturbed by this lesion since the secretory nerves to the sweat glands of the neck, head and face pass by way of the sympathetic nerves in relation with the fourth.

With lesions of the fourth are associated hiccough, Cheyne-Stokes respiration, and in fact any or all respiratory affections. Almost any form of disease of any part above this vertebra may result from a lesion of the fourth, but it is not so important a factor in the etiology of diseases of the head and face as are lesions of the axis or third.

THE FIFTH CERVICAL.

The **fifth cervical** vertebra being a typical vertebra needs little separate description. It is slightly larger than the fourth in every respect, and the body more hooked, which prolongation fits in a corresponding **depression** in the body of the vertebra below. This is true of all the cervical, except the atlas and axis. The obliquity of the spinous process is quite marked, its tip being on a level with the disc between the bodies of the fifth and sixth cervical vertebræ. Movement in this region is quite free. Flexion and extension, though free, are not so marked as in the lumbar spine.

The **effects** on the ligaments of a lesion of the fifth cervical vertebra, that is of the articulation between it and the fourth, are similar to those from a lesion of the fourth. They become tender, thickened and thus hinder normal movement. The size of the intervertebral foramina is lessened, thus producing pressure on the structures passing through. The discs are stretched, or abnormally compressed and soon their elasticity is lessened.

The **muscles** attached to this vertebra are affected in some way by a lesion of its articulations. The principal muscles directly or indirectly involved are the SCALENE muscles, SPLENIUS, COMPLEXUS, MULTIFIDUS, SPINÆ, CERVICALIS ASCENDENS, TRACHELO-MASTOID and DIAPHRAGM.

The **scalenus posticus** is attached to the second rib and in irritative lesions of the fifth cervical, the posterior part of the rib would be drawn upward. This condition is often responsible for diseases of the thyroid gland such as goitre, and for coughs, lung and bronchial disorders. These effects are explained by the fact that the inferior cervical ganglion is

affected by a lesion of the first rib. This ganglion sends a branch directly to the thyroid gland, and connects with the phrenic and recurrent or inferior laryngeal nerve. The inferior cervical and stellate ganglia are situated on the head of the first rib and are affected whenever it is drawn up by contracture of the scalene muscles or from other causes.

The CERVICALIS ASCENDENS is also attached to ribs; the vertebral ends of four or five upper ribs. By its contracture, these ribs are drawn upward at the vertebral end, this condition affecting structures, organs and viscera in relation; lung and mammary disorders being most common. The TRACHELO-MASTOID on account of its attachment to the head, by its contraction draws the head securely against the spinal column. Many a cervical condition attributed to an atlas lesion is in reality the effect of a lesion lower in the spinal column with an effect in the upper part of the neck through this and other muscles attached to the head and upper thoracic spine.

The **arteries** directly involved by a fifth cervical lesion are the vertebral, lateral spinal, muscular and spinal branches of the ascending cervical. As a result of this lesion the parts supplied with blood by these arteries would be affected, viz., brain, cervical spinal cord, medulla and muscles of neck.

The corresponding **veins** would be involved, hence some disorder of the spinal cord, column and cervical muscles and nerves.

The **nerves** involved by a neck lesion are the VERTEBRAL PLEXUS, FIFTH and SIXTH cervical nerves, RECURRENT MENINGEAL, RAMUS COMMUNICANS, MIDDLE CERVICAL GANGLION and the branches of the above named nerves in relation.

The **recurrent** nerve is affected in a way similar to that in other cervical lesions.

The **fifth cervical** nerve divides into the usual anterior and posterior divisions. From this nerve is derived in part or in whole, the PHRENIC, POSTERIOR THORACIC or nerve of Bell, SUPRASCAPULAR, CIRCUMFLEX, MUSCULO-CUTANEOUS, EXTERNAL ANTERIOR THORACIC, SUBSCAPULAR, MUSCULAR and sometimes the MUSCULO-SPIRAL. There is considerable variation in the points of origin of these nerves, hence the variations in the different texts. The phrenic nerve has been described (see fourth cervical nerves.)

The **posterior thoracic** or expiratory nerve of Bell is of interest in that it supplies with motor and trophic impulses, the serratus magnus muscle. It arises by three roots from the fifth, sixth and seventh cer-

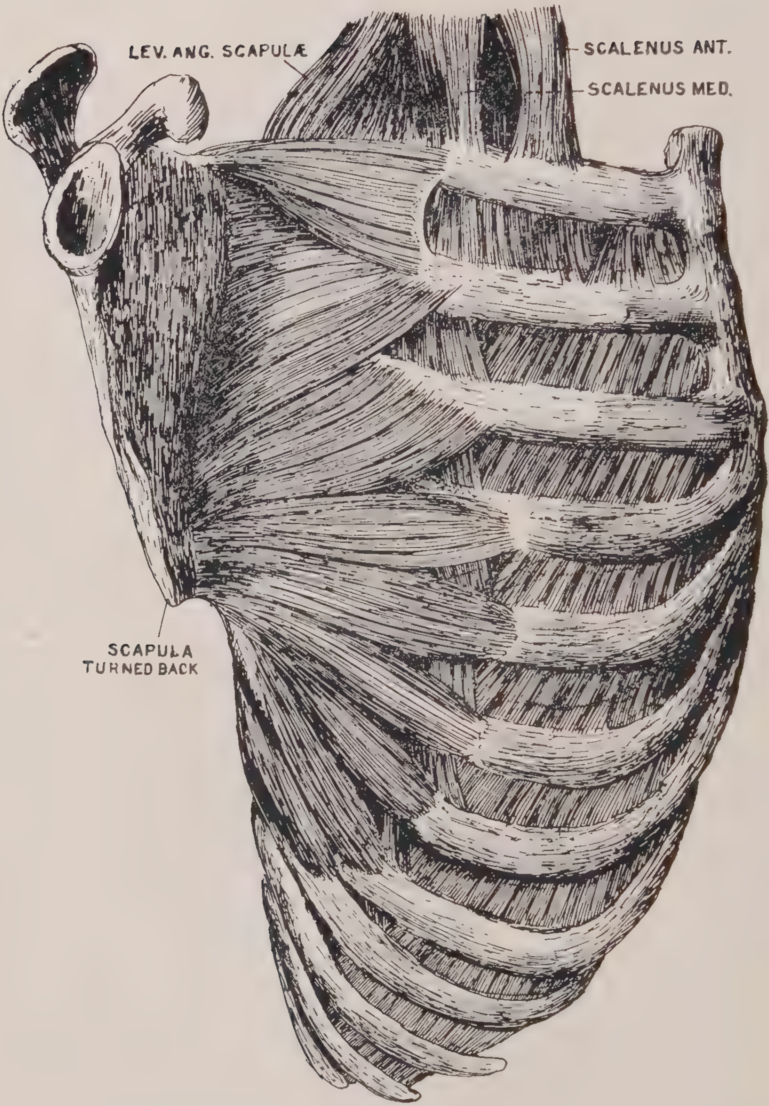

Fig. 22.—Showing attachments of the serratus magnus muscle. The relation it bears to the ribs is clearly brought out.

vical nerves, of which the upper two pierce the scalenus medius muscle. On account of this, contracture of the scalenus would interfere with this nerve. The serratus magnus muscle is of importance in that its function is often disturbed by this lesion, which is followed by marked weakening of the shoulder and scapula. It is occasionally made use of by osteopaths in raising the ribs, this being practical on account of its attachments. This muscle arises by nine digitations from the upper eight ribs, the second getting two of the digitations. The fibers converge to be inserted into the anterior surface of the vertebral border of the scapula. Its action is to draw the scapula and shoulder forward, or if the scapula becomes the fixed point its contraction will evert and raise the ribs and push the sternum forward. It supports the shoulder, as in carrying a weight on it, assists the deltoid in raising the arm by fixing the scapula and holds the scapula closely against the chest wall as is demonstrated in pushing.

The **effects** on this nerve of a disturbance of the articulations of the fifth cervical vertebra are evident. If the nerve is partly or completely paralyzed, as it is in some cases of cervical lesion, the arm cannot be raised to any marked extent, the shoulder is depressed, the ribs get **"down"** and the scapula becomes **"winged."** In complete paralysis of this nerve, the arm cannot be raised above a horizontal plane, except with great effort, and the other movements of the shoulder and arm are markedly weakened.

In **tuberculosis** of the lungs, this muscle is involved in that it becomes atonic with other muscles in relation, thus permitting the scapula to become winged. If this muscle retains its normal tone and function, respiration is usually normal so far as the action of the thoracic walls is concerned; also the ribs remain in a fairly normal position. If a lesion affects its innervation, respiration soon becomes shallow and the ribs become more oblique, closer together and descend or get down. These rib lesions are not always the direct result of an atrophy of the serratus magnus but of atrophy of other muscles as well, the condition of the serratus magnus being a fairly true indication of the condition of the muscles that hold the ribs in normal position.

The **suprascapular** nerve is of importance in that it supplies important structures, the shoulder joint and the supra-and infra-spinati muscles; and clinically is important on account of the frequency of its disturbance. The branch to the shoulder joint has to do with the con-

dition of the structures concerned, that is the synovial membrane, the ligaments and vessels.

In lesions of the fifth cervical, the function of the shoulder-joint is often impaired in that motion is limited and painful and the joint weakened. If the joint is stiff or if movement of the arm produces pain, the condition is popularly called rheumatism. "Rheumatism" of the shoulder is in most cases due to a cervical lesion that in some way affects the suprascapular or circumflex nerve or to a subluxated clavicle. Contracture of the lower cervical muscles will impinge on the circumflex nerve and cause pain to be referred to the shoulder joint because it is one of the sensory nerves to it. Pain in, or rather irritation of, other nerves coming from the fifth cervical segment, will often be accompanied by pain or ache in the shoulder. The effects of a shoulder lesion on this nerve will be considered under the discussion of the circumflex nerve.

The nerve to the spinati muscles is involved in most cases of "cold" in the head. In such cases the supra-spinati are invariably contractured and tender. In la grippe, rheumatism and in an ordinary cold the joints ache, especially the shoulders. An involvement of these muscles is probably the cause. The lesion here acts as a predisposing cause, thus making it possible for the thermic and other influences to act.

The **circumflex** is quite often involved by a lesion of the fifth cervical vertebra. As a result of a disturbance of this nerve several important effects are noted. The shoulder-joint is affected in a way similar to that resulting from a disturbance of the suprascapular. That is, there may be motor, sensory, trophic, secretory and vaso-motor disturbances since this nerve, as is best ascertained by clinical observations, contains filaments for all these functions. On account of this, a lesion affecting the nerve will cause contraction or relaxation of the ligaments, pain or numbness, atrophy, lessened or increased secretion and congestion or anemia of the joint. Dislocations and sprains of this joint produce pain in the integument over the joint, back of shoulder, and at insertion of deltoid muscle. Hilton says that in inflammation of the shoulder-joint the skin over the joint becomes very sensitive. "You will recollect that the same trunks of nerves which form the circumflex nerve transmit some posterior filaments to the skin over the shoulder and the lower part of the neck; hence the pain is experienced in this region, by patients suffering from disease in the shoulder joint." A dislocation of the long head of the biceps which is decidedly unusual,

has a similar effect, that is, the pain is most severe at the insertion of the deltoid. Quite a common mistake is made by referring all such pains to the dislocation of the biceps or injury to the shoulder-joint, when in reality a lesion of the acromio-clavicular articulation is most often the cause. This articulation, that is, the acromio-clavicular,

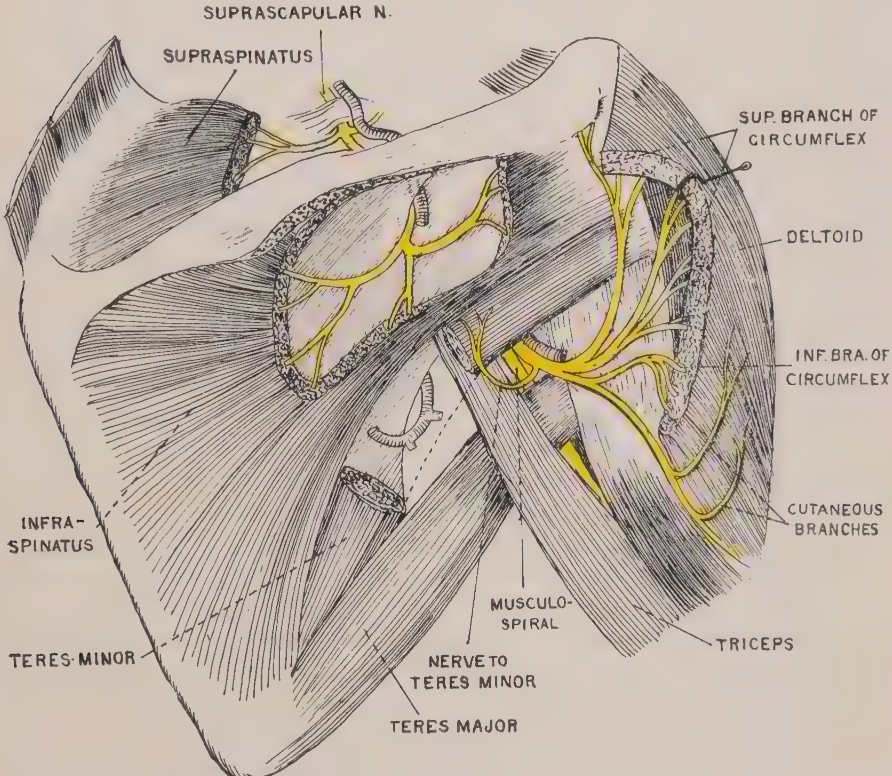

Fig. 23.—Showing relation of circumflex and suprascapular nerves to the shoulder-joint. Painful affections of and around the shoulder-joint are explained by the above illustration.

is often affected by the carrying of weights on the shoulder and by unusual or sudden movements of the arm, and on account of its nerve supply, the effect is usually referred to the upper part of the arm. A typical case may be cited here. The patient is unable to raise the arm above

the level of the shoulder or is unable to draw the arm back as in putting on an overcoat. In other words, any movement wherein the muscles of the shoulder-girdle are used, produces a change of position of the clavicular-acromial joint, hence the referred pain.

In **sprains** of the shoulder-joint the circumflex nerve is injured since the capsular ligament is bruised or torn and thus the nerve is affected since it pierces this ligament. Another filament supplies the deltoid muscle. This muscle has to do with protecting the shoulder-joint, reinforcing its ligaments, rounding off the shoulder and with the movements of the arm. This muscle is affected by lesions of the fifth cervical, shoulder and acromio-clavicular articulations. As a result of these lesions, the muscle does not properly perform its various functions named above. In short, the shoulder is weakened,hence increased tendency to displacement, it loses its round-like appearance and the movements of the arm are impaired. These movements are forward, backward, with outward rotation and especially elevation. The lesions of the acromio-clavicular and shoulder-joints most frequently impair its function as is pointed out above. This muscle atrophies from non-use, as in dislocations or fracture of the humerus, thus injuring the nerve, in anchylosis, or in other diseases of the joint. In ascending neuritis of the circumflex and in anterior polio-myelitis in this region of the spinal cord it is usually atrophied. In atrophy of the muscle, the acromion process appears to be prominent and sometimes, unless care is used, atrophy may be mistaken for dislocation of the shoulder. The writer has seen cases of atrophy of the deltoid follow lesions of the upper thoracic vertebræ in some cases as low as the sixth thoracic.

The circumflex gives off cutaneous branches which supply sensation to integument which covers the middle and lower portions of the deltoid muscle, also a small area of skin below the muscle.

Another filament of this nerve is distributed to the TERES MINOR. This is of importance in that this muscle adducts and rotates externally the humerus, also assists in backward rotation and protects the back part of the shoulder-joint. By a lesion of the fifth cervical, the teres minor muscle may be affected, thus producing an interference with the movements of the arm and a weakening of the shoulder-joint.

The MOTOR EFFECTS on the circumflex nerve of a lesion of the fifth cervical vertebra are paralysis or weakening of the deltoid and teres minor, which impairs the movements of the arm. This results in almost

complete loss of power to raise the arm, a very trifling degree of abduction by the supraspinatus alone remaining.

The SENSORY EFFECTS are characterized by pain, numbness or anesthesia in the skin over the deltoid muscle and in the shoulder-joint. In paralytic lesions, there is loss of sensation in these areas. It is most marked in the skin over the lower part of the deltoid. Gowers says: "Hitzig pointed out many years ago that the anesthetic area is often the seat of vaso-motor paralysis. In some cases there is no anesthesia, even when the muscle is wholly paralyzed; we have seen that this is often the case in nerve lesions." The vaso-motor effects are congestion or anemia of the shoulder-joint and the deltoid muscle. The SECRETORY and TROPHIC effects are characterized by dryness of the joint, the forming of adhesions, atrophy of the ligaments and muscles and weakness of the parts.

The **musculo-cutaneous** and **musculo-spiral nerves** come in part from the fifth cervical. They will be discussed later on (see sixth cervical). The **upper** or **short subscapular** nerve comes principally from the fifth cervical. It supplies the subscapular muscle. This muscle is of interest in that it has to do with internal rotation of the humerus, with strengthening of the shoulder-joint and with holding the humerus in place.

The **external anterior thoracic nerve,** a branch of the fifth cervical, supplies the pectoralis major muscle. This muscle by its contraction draws the shoulder and arm forward and downward. Deaver calls it a hugging muscle. He also says, "It would be a powerful aid in difficult respiration if the arms are fixed. On account of its attachment to the anterior portions of the upper ribs and to the arm, it is used to elevate the chest or raise the ribs," which is accomplished best by making a fixed point at the vertebral end of the rib and extending the arm above the head. A disturbance of its function results in impaired movements of the shoulder and arm, a weakening of the attachment holding the tendon of the biceps in its groove and a dropping of the anterior ends of the ribs. Its degree of development is an indication of the general strength of the patient.

The distinctly muscular branches supply the rhomboidei and subclavius muscles. In colds of the head and bronchial tubes these muscles, that is the rhomboidei, are markedly contractured. This contractured condition interferes with the circulation to the spinal cord in that area and

the position of the vertebræ to which they are attached. This condition finally leads to weakening of the bronchial tubes and lungs, and predisposes to tuberculosis of the lungs. Repeated colds cause repeated contractures of these muscles. After the lungs begin to waste these muscles degenerate. In some cases they can be seen as fibrous cords. In most chronic cases they are relaxed and the scapula becomes so loosely attached to the thoracic wall and spinal column that the hand can easily be inserted beneath it. In acute cases the scapulæ are drawn together. The muscles supplied by the fifth segment of the spinal cord are: the longus colli, scalene, levator anguli scapulæ, serratus magnus, subclavius, supra-spinatus, infra-spinatus, teres minor, subscapularis, deltoid, pectoralis major, biceps, brachialis anticus and multifidus spinæ.

The fifth cervical nerve also furnishes filaments which supply the **humerus** and its **periosteum.** This is of importance not because disease of the bone is not unusual, but because its nerve supply is seldom taken into consideration. Nearly all cases of caries are attributed to tuberculosis, but back of all these so-called tubercular conditions are lesions of some sort that impair the vitality of the bone. A lesion of the fifth cervical will affect the **nutrient nerve** to the humerus and in some cases this disturbance is sufficient to produce a change, possibly caries. Another branch passes to the **brachial artery** which appears to carry vasomotor impulses to it.

The size of the artery is partly controlled by this nerve. In vascular disturbance of the arm the trouble may be in this branch to the artery.

The fifth cervical segment supplies in whole or in part the shoulder-joint, elbow and wrist. In many cases of "rheumatism" of the joints of the arm the trouble is a lesion impairing the nerve supply. This lesion may be in the articulation itself or at the fifth cervical, at which point the nerve is in relation, that is, the cause may be in the spine but the effect is in the joints of the arm. This may work in just the opposite way, that is, the wrist, elbow, or shoulder-joint may be impaired and the pain be felt in the cutaneous areas supplied with sensation by the fifth cervical. A sprain of the wrist may cause pain to be felt the entire length of the arm or between the shoulders. In most cases there is a reflex contracture of the muscles supplied by the same segment.

The fifth cervical nerve supplies sensation to the integument over the deltoid, middle and lower portions, radial aspect of forearm and in most cases the ball of the thumb. It communicates with the fourth

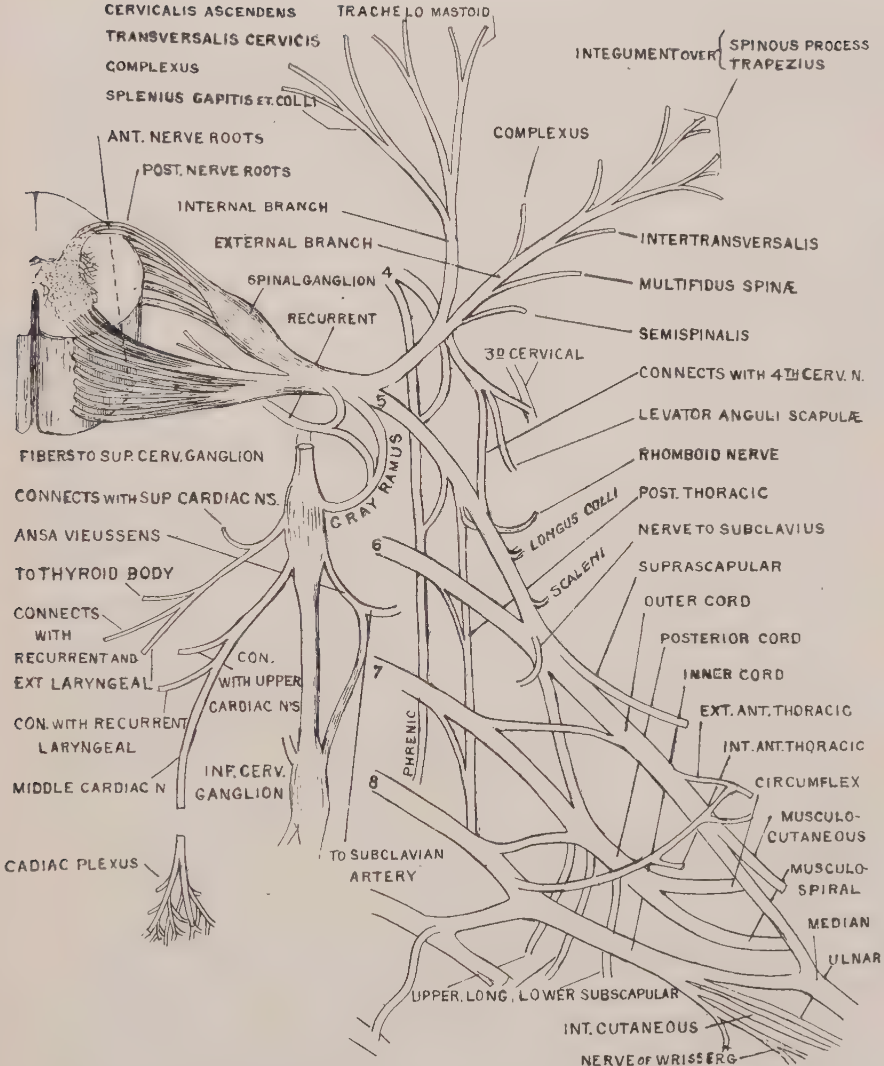

FIG. 24—Showing the fifth cervical segment with its nerves and their distribution.

and sixth cervical and the middle cervical ganglion. The recurrent meningeal is formed from the fifth cervical and the corresponding grey ramus and is affected by the lesion. The vertebral plexus would be involved similarly to that from a lesion of the vertebra above. The posterior division of the fifth cervical nerve divides into the usual internal and external branches. The internal branch supplies the semispinalis and complexus muscles, pierces the trapezius and supplies in part the integument over the back part of the neck. The external branch is small and helps to supply the muscles in relation, viz., splenius, transversalis colli, complexus, trachelo-mastoid and the cervicalis ascendens. The posterior division of this nerve is often the seat of pain referred from diseased conditions in which the anterior branches are involved. In colds from exposure of the neck this nerve is the one first affected. Lesions of the fifth cervical weaken the tissues supplied by this division, hence the power to resist the effects of thermic changes is lessened.

The **middle cervical ganglion** is located opposite the sixth cervical vertebra in front of the bend in the inferior thyroid artery, hence it is often called the thyroid ganglion. It seems to be formed by the coalescence of the fifth and sixth cervical ganglia and is sometimes wanting. It gives off several efferent branches: the thyroid, which follow the artery to the thyroid gland, the middle cardiac, branches to the common carotid artery, and the external branches or grey rami that join the fifth and sixth cervical nerves. From the loop, or **ansa subclavia,** connecting the middle and inferior cervical ganglia, spring branches which supply the SUBCLAVIAN ARTERY by way of the plexus subclavius, the INTERNAL MAMMARY ARTERY and in some cases, communicate with the PHRENIC nerve. Branches to the thyroid gland arise from the inner side of the ganglion. These fibers communicate with the superior cardiac, the recurrent and external laryngeal nerves. This explains, in a measure, the throat and heart complications of exophthalmic goitre. Most of these branches follow the terminal divisions of the inferior thyroid artery.

The **middle cardiac** (nervus cardiacus magnus) also comes from this ganglion. It terminates in the deep cardiac plexus after communicating with the upper cardiac and the recurrent laryngeal. Clinically and experimentally, this nerve has little or nothing to do with the action of the heart. On account of the scarcity of cases of heart disorders from this lesion, it proves one of two things; that either few if any impulses

for the heart pass through the upper cervical sympathetic nerves or else, a vertebral lesion will not, under ordinary circumstances, affect the gangliated cord in relation unless impulses pass from the spinal cord to the sympathetic chain at that point. The cardiac impulses arise in the upper thoracic portion of the spinal cord and pass out of the spinal canal through the intervertebral foramina in relation and at this place they are interrupted.

The function of the middle cervical ganglion seems to be that of transmission and distribution of impulses that arise in the upper thoracic spinal cord. They are motor, secretory and vaso-motor in function, and pass to the neck, head and face. Most of these impulses pass on through the ganglion to parts above while a few are distributed by means of the efferent branches of this ganglion, viz., vaso-motor to the thyroid gland, and to the neck, shoulder, arm, cervical spinal cord and meninges. Secretory impulses for the cervical sweat glands pass through this ganglion and out over its efferent fibers to their destinations.

The conclusions we draw from this knowledge of the middle cervical ganglion are: exophthalmic goitre may follow a lesion affecting this ganglion because the vaso-motor nerves to the thyroid gland come in part from this ganglion. Goitre seems to be a vascular disturbance, and a lesion of the fifth cervical vertebra will affect the middle cervical ganglion from which arise branches that supply the gland. The heart may be involved on account of relation to, and connection with the great cardiac nerve. The heart may be affected independently of the disturbance of the thyroid gland but clinically it is rare for a lesion of the fifth cervical to cause heart disturbances, although it does happen. Throat disturbances, vaso-motor, motor and sensory, result from an impairment of the middle cervical ganglion, which are explained by the above named nerve connections. Arm troubles, especially such as arise from a vascular disturbance, will in some cases result from a lesion affecting the middle cervical ganglion because the subclavian plexus is derived in part from it. The parts supplied by the internal mammary artery may likewise be involved because of a similar reason.

The fifth cervical segment contains nerve cells or centers that give origin to motor impulses that result in movement of that part of the spine, shoulder and arm, hence a lesion affecting this segment, and a subluxation of the fifth cervical will in all probability do it, will impair the movements of the head, neck, shoulder and arm.

Sensation to the integument over the lower part of neck and over deltoid muscle, the shoulder and acromio-clavicular articulations, also the elbow and wrist and the ligaments of that part of the spine, is controlled by the condition of the sensory cells in the ganglion on the posterior root of the fifth cervical. The vaso-motor fibers supplying the vessels of the shoulder, arm, fifth cervical vertebra, fifth cervical segment of the spinal cord, meninges and muscles in relation, are more or less affected by a lesion involving the fifth cervical vertebra because they are in relation. The diseases to be associated with a lesion of the fifth cervical are: disturbances of circulation to the brain, producing in some cases epilepsy; eye diseases; goitre and shoulder disturbances, especially the so-called "rheumatism of the shoulder." Goitre comes directly as a result of the lesion by which the nerves and vessels to the gland are involved, or indirectly through displacement of the first rib as a result of muscular contractures.

The lesions in this part of the spinal column, that is the middle cervical region, are not so important in the production of visceral and vaso-motor disturbances in the parts above, as are those of the upper part of the neck and the upper thoracic region. Clinically, it is the exception to find the cause of any cranial disorder in the middle or lower cervical region, compared with the frequency of locating it in the upper cervical and thoracic areas. There are, however, some cases in which the visceral and vaso-motor disorders of the head and face are caused by a lesion of the middle cervical vertebræ. The explanation, as it appears to me, is, that few if any vaso-motor impulses destined for the head, pass through the intervertebral foramina in this region. Practically all, if not all of them, pass out of the spinal canal at a point below, and reach their destinations by way of the gangliated cord and the superior cervical ganglion, and its ascending branches. In ordinary vertebral lesions, little if any pressure is exerted on the gangliated cord in relation. Vertebral lesions produce most of their effects by lessening the size of the intervertebral foramina. Therefore, a lesion of the fifth cervical vertebra will not produce such a marked visceral or vaso-motor effect, as would a lesion of the second thoracic or the axis,because but few vaso-motor impulses for parts above pass through the fifth or sixth intervertebral foramen, at which point they might be affected by the lesion, but pass over the gangliated cord which is fairly secure from pressure by the average subluxation.

THE SIXTH CERVICAL.

The **sixth cervical vertebra** is also a typical vertebra, hence needs little separate description. All its parts are slightly larger than those of the fifth. The spine is longer and larger, the body more hooked or beaked. The transverse processes are not always perforated for the passage of the vertebral vessels. Immediately above the transverse process of the seventh cervical the anterior tubercle or the front of the transverse process of the sixth, can be palpated quite readily if the head is moved from side to side. On account of its relation to the carotid artery it has received the name of carotid tubercle. This bony enlargement or apparent irregularity, should not be mistaken for a lesion of the sixth, even though it be quite prominent. The facets are directed upward, inward and backward. The movement of its articulations is less than that of the various articulations above, and the spinous process is often very near the spine of the seventh. It approaches the thoracic type of vertebræ.

It is subject to lesions very similar in character to lesions of the vertebræ above; perhaps as in the fifth, the most common lesion being an anterior one. The effect on the ligaments is that of rupturing fibers in them, this, as stated before, producing swelling and tenderness in the ligament. The muscles involved, that are important, are the cervicalis ascendens, trachelo-mastoid, multifidus spinæ, complexus and splenius colli. All of these muscles have been considered above.

The **arteries** are the vertebral and its lateral spinal branch and the lateral spinal from the ascending cervical. A disturbance of them would follow a lesion of the sixth, hence vascular disorders of the cervical spinal cord and part of the brain. The corresponding veins would be disturbed by this lesion in a way similar to that from a lesion of the cervical vertebræ above.

The **nerves** that have their center in the sixth cervical segment or that would in some way be affected by a lesion of the sixth cervical are the suprascapular, long or posterior thoracic, external anterior thoracic, subscapular, circumflex, median, musculo-cutaneous, musculo-spiral, muscular, recurrent meningeal, vertebral plexus, and the middle cervical ganglion and its branches and connections.

By affecting the supra-scapular, there would be a pathological change in the spinati muscles and the shoulder-joint.

The long or posterior thoracic supplies the serratus magnus, hence in lesions affecting it there is difficulty in raising the arm above the horizontal position, the contour of that part of the spine is altered, and the position and movement of the ribs changed.

A disturbance of the external anterior thoracic would affect the pectoral muscles.

The subscapular nerve supplies the latissimus dorsi, subscapularis and teres major. There are three of these nerves, the **upper** or short, the **middle** or long and the **lower subscapular.** The upper is distributed exclusively to the subscapularis muscle. The long supplies the latissimus dorsi muscle, and the lower is distributed to the teres major. These muscles strengthen and support the shoulder-joint, the bicipital tendon, and help to fix the scapula. In affections of the nerve supplying the subscapularis muscle, inward rotation of the humerus is lessened. If the long subscapular nerve is paralyzed, "forcible backward depression of the raised arm is lost, and the shoulder cannot be put back without being also raised (by the trapezius). The teres major muscle has to do with drawing the humerus backward and inward as in climbing. In paralysis, the elevation of the shoulder, with the arm against the side, is lost" (Gowers). In lesions of the sixth, the movements of the scapula and humerus would be affected and the shoulder-joint weakened.

In lesions of the sixth cervical and shoulder-joint, the circumflex is involved hence impaired movements of the arm, pain in joint and over shoulder, and sometimes atrophy and anesthesia. The deltoid is also involved.

The **musculo-cutaneous** nerve is of importance in that it supplies the coraco-brachialis, biceps and brachialis anticus muscles, the humerus, its nutrient artery, the elbow and wrist-joints and sensation to the thenar eminence and skin of the forearm, outer side, as far as the wrist. Lesions involving it would result in an impairment of the muscles innervated, malnutrition of the humerus, stiffness of the elbow- and wrist-joints and sensory disturbances of the posterior and outer aspect of the forearm and thenar eminence of the hand.

The **median** nerve is of importance from a pathological standpoint on account of the character of effects from involvment of it. This nerve supplies sensation to the palm of the hand, palmar surface of three and one-half fingers, and pulp under nails on first three and one-half fingers. It supplies the muscles of the thumb, flexors of the wrist and long flexors

of the fingers. The elbow, wrist, metacarpal and phalangeal joints are supplied by it. Progressive muscular atrophy is manifest first by atrophy or wasting of the muscles composing the thenar eminence. The **thenar** eminence is composed of four muscles, viz., the adductor pollicis, opponens pollicis, abductor pollicis and the flexor brevis pollicis. All of these muscles with the exception of the adductor pollicis, are supplied by the median nerve. Progressive muscular atrophy is due to progressive impairment of the motor and trophic cells in the lower cervical segments of the spinal cord, which is determined by the fact that the effect of the disease is first manifested by atrophy or wasting of the thenar eminence which is supplied by the median and ulnar nerves, they having their origin in the lower cervical and upper dorsal segments of the spinal cord. A lesion of the sixth cervical vertebra will affect the median nerve either at its origin or exit and cause a paralysis, partial or complete, with symptoms identical with, or very similar to the disease recognized as progressive muscular atrophy. There seems to be, judging from clinic cases, trophic centers for the arm in the upper thoracic spinal segments, (upper four), hence lesions in that area may cause this disease. From an osteopathic viewpoint, the lesions of the lower cervical and upper thoracic vertebræ are the most important causes of this disease, these lesions causing the disease by disturbing the circulation through the motor and trophic areas in which are located the cells governing the arm. These cells are in the anterior horns of the grey matter of the spinal cord. These lesions alter the size of the intervertebral foramina, thus producing pressure on the blood-vessels passing through them; this interfering with the nutrition of these nerve cells. The causes usually mentioned as responsible for progressive muscular atrophy are recognized as exciting ones, but probably of themselves are not sufficient to produce the disease.

The **musculo-spiral** nerve would be more or less affected by a lesion of the sixth cervical vertebra. It supplies the extensor muscles of the elbow-joint and wrist, sensation to the posterior and outer aspect of the upper arm, forearm and hand and sends articular branches to the elbow, wrist, metacarpo-phalangeal and phalangeal articulations. This nerve on account of its course, is more frequently injured than the other nerves of the brachial plexus. Fractures of the humerus, pressure from the use of a crutch, lead and alcoholic poisoning are important causes of disturbance aside from the above mentioned lesions. Wrist-

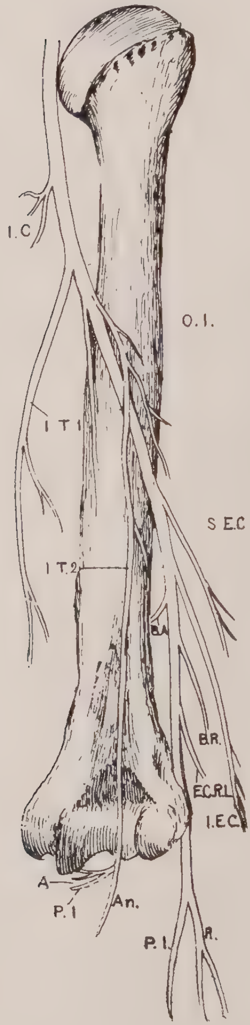

FIG. 25.—The musculo-spiral nerve and its branches. Note relation to humerus. O. I. nerve to outer head of biceps; S. E. C. superior ex. cut; B. R., N. to brachio-radialis; E. C. R. L., N. to extensor carpi radialis longior; I. E. C., Inf. ex. cut.; R., radial; P. I., post. interossous; An. N. to anconeus; I. T. 1 & I T. 2, nerves to triceps; I. C., Internal cutaneous.

drop follows a paralysis of the extensor muscles of the wrist, also wasting of other muscles in relation. Other effects may follow lesions affecting it since many movements of the forearm, wrist and fingers, depend on this nerve. Dana says: "Its function is to extend and supinate the forearm, to extend the wrist and fingers, and to adduct and abduct the fingers slightly." These varied movements would of necessity be impaired if the nerve were affected, which is the case in lesions of the lower cervical vertebræ.

The important muscles supplied by the sixth cervical nerve are the scalene, serratus magnus, subscapularis, teres major, deltoid, pectoralis major, biceps, multifidus spinæ, the extensors of the wrist and flexors of the thumb. All of these have been considered except the biceps. This muscle is of interest in that its long head is supposed to be subject to displacement. This head "arises by a long tendon from the top of the glenoid cavity and the glenoid ligament and, arching over the head of the humerus within the capsule of the shoulder-joint, pierces the latter between the two tuberosities and descends in the bicipital groove between them covered with a reflection of the synovial membrane of the joint, which serves to lubricate it and facilitate its movements." It is held fairly well in place by the attachments of the pectoralis major muscle. Occasionally this tendon becomes torn loose from its mooring and gets out of the groove, but I believe this to be an exceptional accident. In most of the cases diagnosed as a dislocation or "slip" of this tendon, the acromio-clavicular articulation was found impaired, in other words a **subluxated clavicle,** acromial end, was found. If the tendon is displaced, all the movements wherein the biceps muscle is used, are painful.

Pain in and over the muscle often comes from neck, shoulder and clavicle lesions.

The extensor muscles of the wrist were considered with the musculo-spiral nerve.

In spinal cord diseases,groups of muscles are affected since the segments of the cord are involved and, usually, all the muscles innervated by the diseased segment are affected. This is especially true in anterior polio-myelitis.

The **posterior division** of the SIXTH is also involved by a lesion of the corresponding vertebra. As a result, the muscles supplied are affected and the integument over the lower part of the neck is disturbed as to sensation.

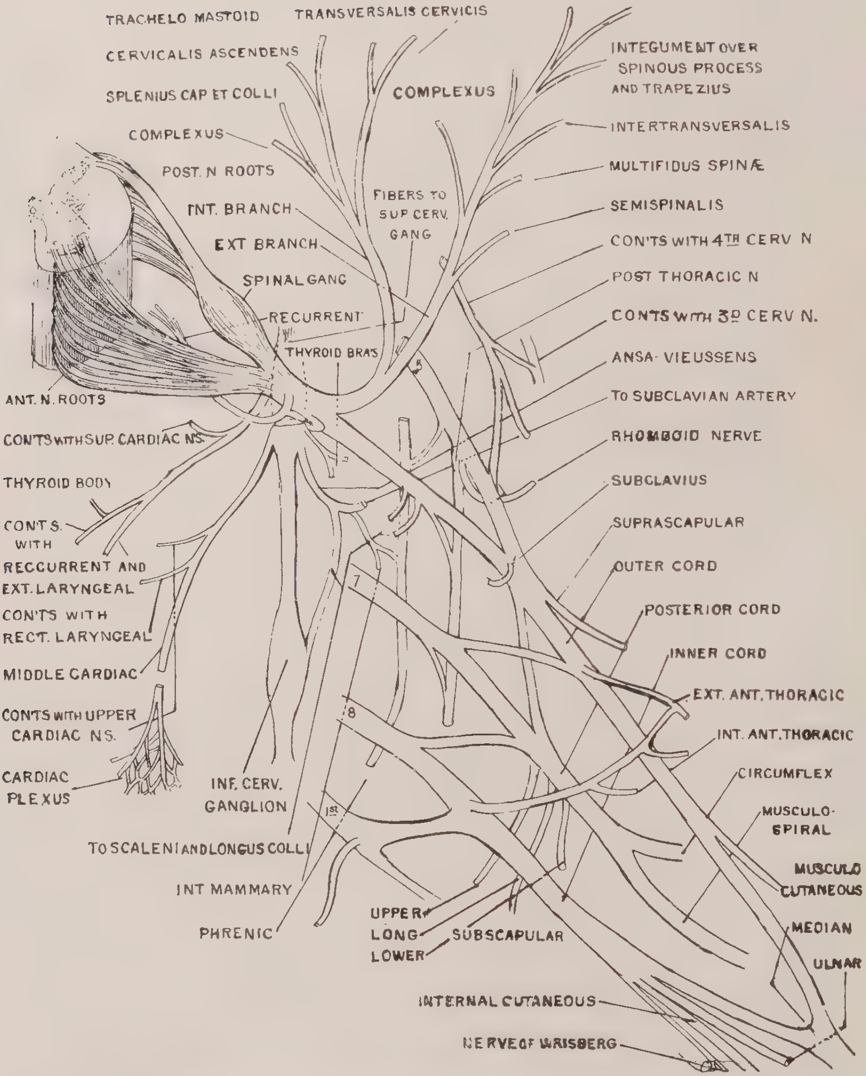

FIG. 26.—Showing the sixth cervical segment with its nerves and their distribution.

The **recurrent meningeal** which supplies in particular the sixth cervical segment of the spinal cord, is usually involved by a lesion of the sixth.

The **vertebral plexus** is in relation, usually entering the transverse process of the sixth, and would be disturbed in some way by a lesion of this bone. This furnishes an explanation of eye disturbances from lesions so low in the neck.

The **grey ramus** connecting the middle cervical ganglion with the sixth nerve is very liable to injury in lesions of the sixth.

The **middle cervical ganglion** is in relation with the transverse process of the sixth and is frequently affected in lesions of this vertebra. This ganglion gives off branches that supply the heart, thyroid gland, common carotid artery, arm, and indirectly sends filaments to the phrenic and occasionally the mammary artery. It communicates with the recurrent laryngeal, external laryngeal, superior cardiac, superior and inferior cervical ganglia, on which account many disturbances of the parts innervated by these nerves come from lesions of the lower cervical vertebræ, those of the fifth and sixth, affecting this ganglion.

The **parts affected** by a lesion of the sixth cervical are: the **first rib,** it being pulled out of place by the contractured scalene muscles, this lesion affecting their innervation; the wrist-joint, the shoulder and hand; the scapulæ on account of the disturbance of the nerve of Bell; the chest wall; the brain, such a lesion sometimes producing epilepsy since the vaso-motor tracts are involved; and the eyes through the cervical sympathetic and the vertebral plexus. There may be pain or numbness of the arm and hand and between the upper parts of the scapulæ. The thyroid gland is often affected, exophthalmic goitre being common. The heart is sometimes involved. The throat is affected, a dry hacking cough being the most common condition. The eye, arm and throat are most frequently affected by a lesion of the sixth cervical vertebra.

These effects are not the results of pressure of the displaced bone on the nerves as commonly as they are the results of a disturbance of the nutrition of the nerve cells. Pressure of the displaced vertebra on a cerebro-spinal nerve would produce some sensory disturbance, as is demonstrated by pressure on the ulnar. These nerves are mixed, and pressure on them will affect the sensory element in preference to the motor. If the irritation is severe, there will be both a sensory and a

motor effect. In lesions characterized by **painful effects,** the nerve is affected **external** to the spinal cord. In spinal lesions in which there is only a **motor** effect, the cells of the spinal cord are affected, as in anterior polio-myelitis. In short, if the disorder is in the cells of the spinal cord, the effect is a motor one, but if it is external to the cord it may be sensory or both sensory and motor, seldom is it a purely motor effect. In a general way, use can be made of this in the diagnosis of the cause of the particular pain or motor disorder, that is, in determining whether the trouble is in, or external to, the spinal cord.

THE SEVENTH CERVICAL.

The **seventh cervical vertebra** is called a transitional vertebra in that it has characteristics of both the cervical and thoracic. Its most marked peculiarity is the very long, non-bifurcated spinous process on which account, it is called the **vertebra prominens.** The transverse process is quite large, especially the vertebral or posterior part, it ap-

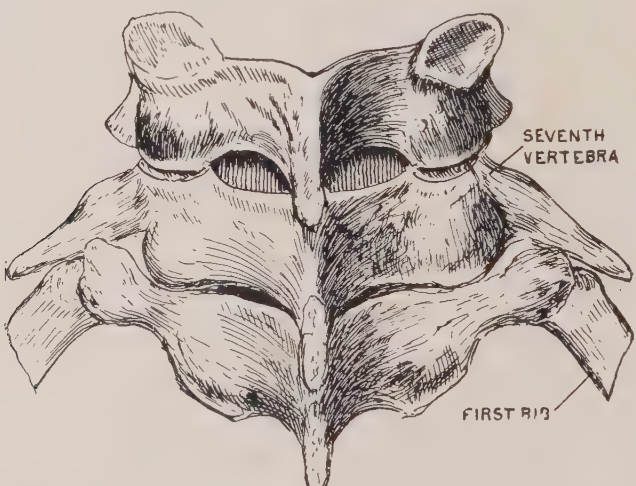

Fig. 27.—Showing cervical ribs. Drawn from a dissection made at the A. S. O. On one side the rib was anchylosed, on the other, the articulation was freely movable.

proaching in appearance the transverse processes of the thoracic vertebræ. It is seldom pierced by a foramen like those above, but in some cases a small foramen is present which transmits à vein.

The **superior facets** face almost directly backward and present a flat surface. The principal motion here is a gliding one although nearly all the ordinary neck movements are present but considerably limited. It is somewhat more posterior than the sixth, it taking part in the normal posterior swerve of the upper thoracic spine. The **movements** at the articulation between the sixth and seventh cervical are very limited, on account of which is the possible explanation of this articulation being involved less frequently than those above in which movement is more marked. Its most common lesion is a forward rotation by which the spines of the seventh and sixth are approximated. As a result of this there is a separation of the spines of the seventh and first thoracic vertebra or what is ordinarily called a "break." As a rule in these breaks or separations, the **vertebra above the break** is the one **involved.**

In this part of the spine the usual **bony lesion** consists of an alteration in position of the articular facets caused by **one part** or section of the spinal column being **forcibly moved,** to a pathological extent, **on the other.** As a result of a lesion of the articulation between the sixth and seventh cervical vertebræ, its ligaments, muscles and foramina; would be disturbed in some way. The effect on the ligaments is usually one of undue traction quite often to a pathological degree.

The **ligamentum nuchæ** is attached to the spine of the seventh and extends to the crest of the occipital bone, it being attached to the spines of all the cervical vertebræ. Although it is more or less affected in any cervical lesion it will be discussed here. In man it is rudimentary; in the horse, ox, etc., it is well developed and constitutes an elastic support of the head. In man it occasionally becomes contractured and tender, which conditions are associated with **occipital headache** and a drawing sensation in the back of the neck. Flexion of the head on the chest causes pain if the ligament is shortened, as it is in most pathological conditions, but such treatment is often helpful in relieving pain in the neck. Care should be used in stretching this ligament lest too much force be exerted on account of the leverage, the ligament be injured or a vertebra pulled out of line. In palpating in the median furrow of the neck, pressure should be made to one side of this ligament since by so doing the condition of the deeper structures can the better be ascertained.

The important muscles attached to this vertebra and which would therefore be affected by a lesion of it, are the **trapezius, rhomboideus major, serratus posticus superior, splenius, multifidus spinæ, levator**

costæ, scalenus posticus and **medius, complexus** and **trachelo-mastoid.** Since the posterior part of the vertebra is usually rotated upwards and forwards, the muscles attached to points below would be put on a tension. The serratus posticus superior in such a case, would pull up on

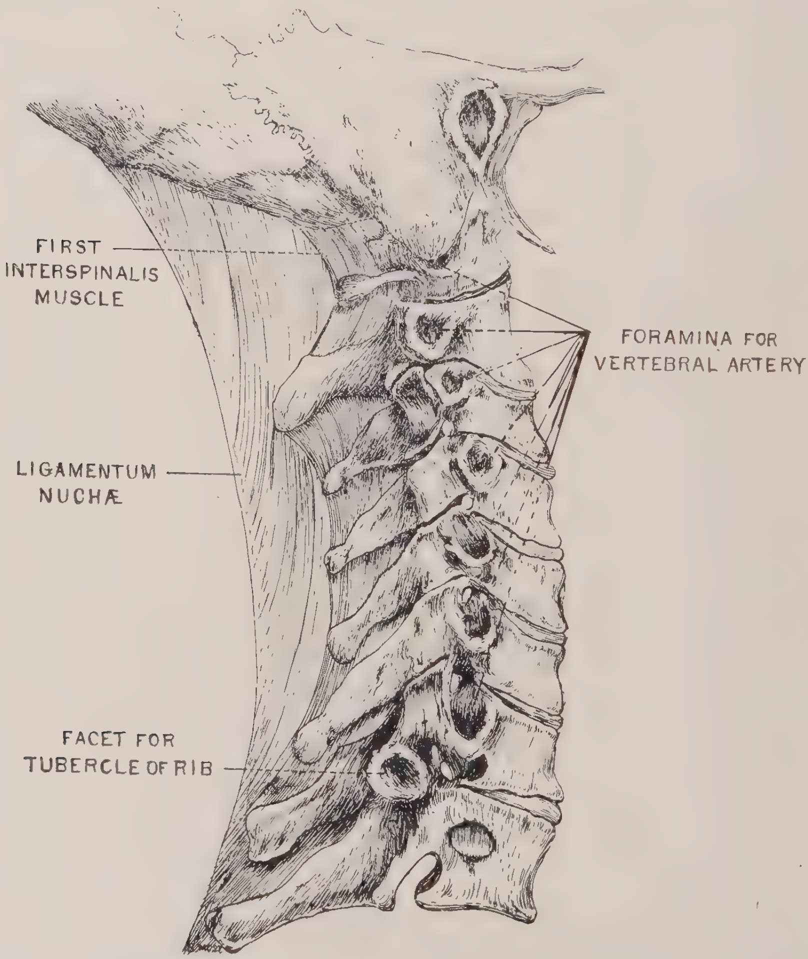

Fig. 28.—Showing ligamentum nuchæ. This ligament often becomes contractured and tender, which condition tends to produce headache accompanied by a drawing sensation in the back of the neck.

the angles of the upper ribs, this condition in turn affecting the thoracic viscera by altering the position of these ribs. The disturbance of the levatores costarum muscles would have a similar effect,that is the vertebral end of the ribs would be displaced or at least drawn slightly upward. This is the usual form of rib displacement and probably is accounted for by the above arrangement of the muscles. The scalene help to produce this form of rib lesion in the upper two ribs.

It is not unusual for such a lesion to produce a painful contracture of the above named muscles. In such cases there is a constant ache in the lower part of the neck and the upper thoracic region and marked flexion produces an acute pain. The patient complains of a dull, chronic ache in the region of the seventh, catches cold quite easily and any exercise wherein these muscles are used, produces fatigue of this part.

The **arteries** involved by a lesion of the seventh, are the vertebral and its lateral spinal branch (not constant), the lateral spinal branch of the ascending cervical and the lateral spinal branch of the superior intercostal artery. The corresponding veins are affected, thus producing disturbance with the drainage of the muscles of this region and especially of the spinal cord and its coverings. The effects vary with the degree of congestion and the function of the part involved. As a rule passive congestion lessens activity, or at least the function of the part congested is perverted.

The **nerves** involved by a lesion of the seventh cervical vertebra, are those passing out through the foramina above and below it, these being directly involved, while their communications and connections are indirectly affected. On account of the extra cervical segment, both sets of nerves will be considered in connection with the seventh, instead of only the nerves passing through the seventh cervical intervertebral foramen, that is the nerves above the corresponding vertebra as we have done in the other cervical nerves.

The nerves in relation with the seventh are the **posterior thoracic, subscapular, ulnar, median, musculo-spiral, internal anterior thoracic, internal cutaneous, muscular, recurrent meningeal,** possibly the vertebral plexus and the **inferior cervical ganglion** and its branches and communications.

The **posterior thoracic** is involved in winged scapulæ, that is in relaxed conditions of the serratus magnus muscle, and has been considered.

The **subscapular** supplies the subscapular and latissimus dorsi mus-

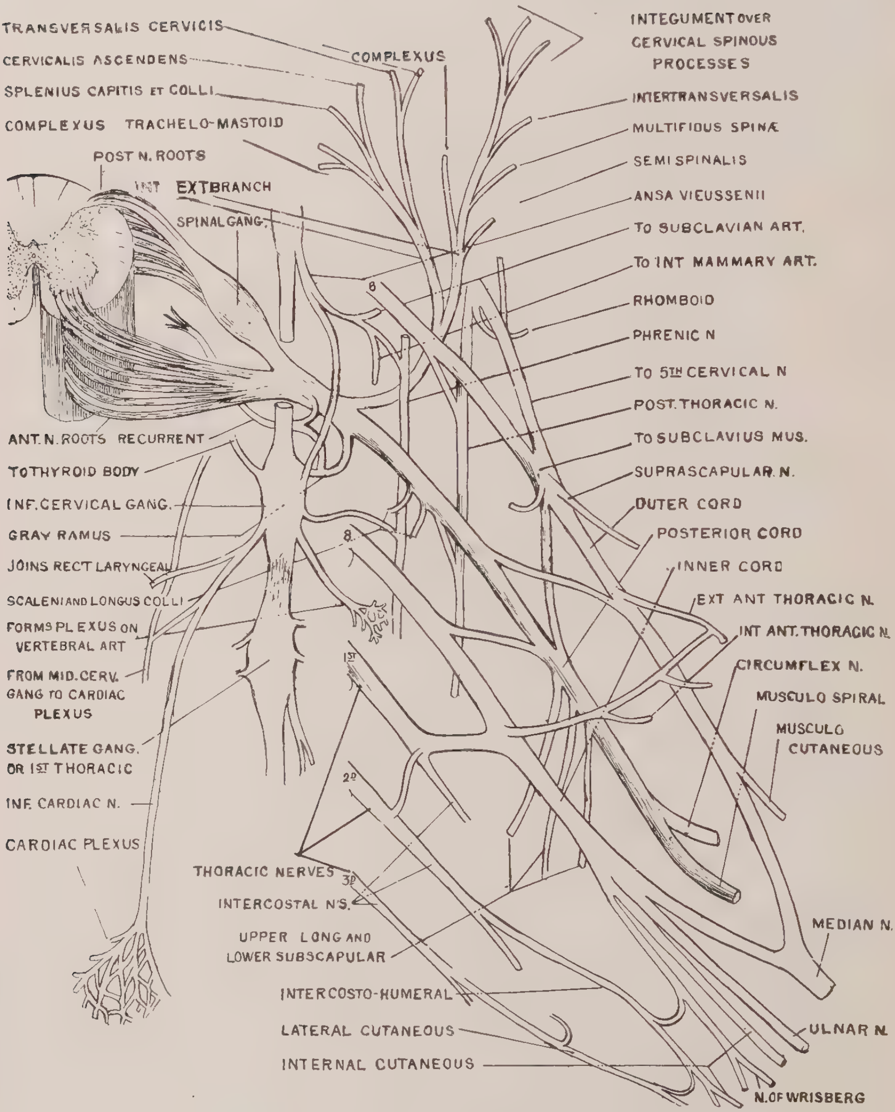

FIG. 29.—Showing the seventh cervical segment with its nerves and their distribution.

cles and is principally motor, controlling the position of the scapula and backward movements of the arm.

The **ulnar,** the "crazy bone" nerve is of interest to us. **Pain** or other sensory disturbance in the hypothenar eminence, little finger, ulnar side of ring finger, or back of hand (ulnar aspect) is the result of direct or indirect disturbance of this nerve. **Numbness** in the little finger, the left being more frequently involved than the right, is quite a common condition in the aged and in patients subject to heart disease, particularly angina pectoris. Pain in the lower part of the forearm is, to a certain extent, due to an interference with the ulnar nerve. Many of these sensory disturbances are reflex from lesions of the elbow, shoulder and lower cervical and upper thoracic vertebræ. The segments of the spinal cord that give rise to impulses that pass to the ulnar nerve also give origin to impulses that supply the heart and lungs. Applying Head's law we then have an explanation of angina pectoris and valvular disease producing numbness or pain in the little finger. Eckley offers an explanation that is slightly different: *"(1) The heart is supplied by sympathetic nerves by the cardiac plexus; (2) the sympathetic nerves forming the cardiac plexus communicate with the somatic nerves in the area where are given off the nerves forming the brachial plexus; (3) as sensory nerves report pain peripherally, we may logically account for the digital pain in valvular lesions in the distribution of the brachial plexus in general, or in the specific distribution of the ulnar nerve in particular."

Since this nerve supplies the majority of the intrinsic muscles of the hand, muscular disturbance of the hand, that is atrophy and contracture, result from lesions involving the ulnar nerve, a lesion of the seventh cervical not being unusual. In **progressive muscular atrophy** this nerve with the median is primarily involved, at least the effects of this disease are first evident in the parts supplied by them, viz., the muscles of the thumb that form the thenar eminence. In eversion of the hand, as in rheumatoid arthritis, this nerve is in all probability the first to be involved. If the **grip** is **weakened** this nerve is affected, since it supplies the deep flexors of the fingers.

The **median** nerve has been considered with the sixth cervical segment. The principal point to be remembered concerning it is its connection with **progressive muscular atrophy.**

*Practical Anatomy, p. 265.

The **musculo-spiral** is at fault in wrist-drop and is often injured in fractures of the humerus or by an improperly worn crutch.

The **internal anterior thoracic** nerve supplies the pectoral muscles, hence in disturbance of them this nerve is usually at fault.

The **internal cutaneous nerve** is sensory, supplying the integument of the upper and inner aspect of the arm, and the posterior and internal part of the forearm as low as the wrist. It communicates with the musculo-spiral and ulnar nerves. Pain in these regions is usually the result of disturbance of this nerve. The cause of the disturbance may be at the seventh cervical vertebra or it may be reflex from disease of viscera supplied by the same segment in which are the cells that give rise to this nerve.

In addition to the muscles described as innervated by the above nerves the posterior division gives off **muscular** branches that supply the multifidus spinæ and other muscles.

The **articulations** of the elbow, wrist and hand are also supplied by the seventh and would be involved by a lesion of the seventh cervical vertebra. Thus **dryness** of these joints, **pain** and **rheumatic affections** are directly attributed to a lower cervical lesion. In some instances the brachial plexus receives filaments from the left vagus. McClellan states that in "two dissections made within the last year, the author has found distinct branches passing from the pneumogastric on the left side to the brachial plexus." This is of value in associating pain in the arm with cardiac disease, such as angina pectoris and valvular disease or endocarditis.

The posterior divisions of the seventh and eighth cervical, do not supply sensation to the integument in relation as do those above and below. The cutaneous nerves of this region come from the posterior divisions of the sixth and first thoracic nerves.

The **inferior cervical ganglion** is in relation with the seventh cervical vertebra, connects with the seventh and eighth cervical nerves, and is involved in lesions of this vertebra. The branches of this ganglion are: **grey rami** communicantes which pass to the anterior division of the seventh and eighth cervical nerves; the **subclavian** loop connecting the inferior and middle cervical ganglia; a small branch, sometimes wanting, which communicates with the **recurrent laryngeal; inferior cardiac;** and branches that form the **vertebral, inferior thyroid,** and **internal mammary** plexuses of nerves.

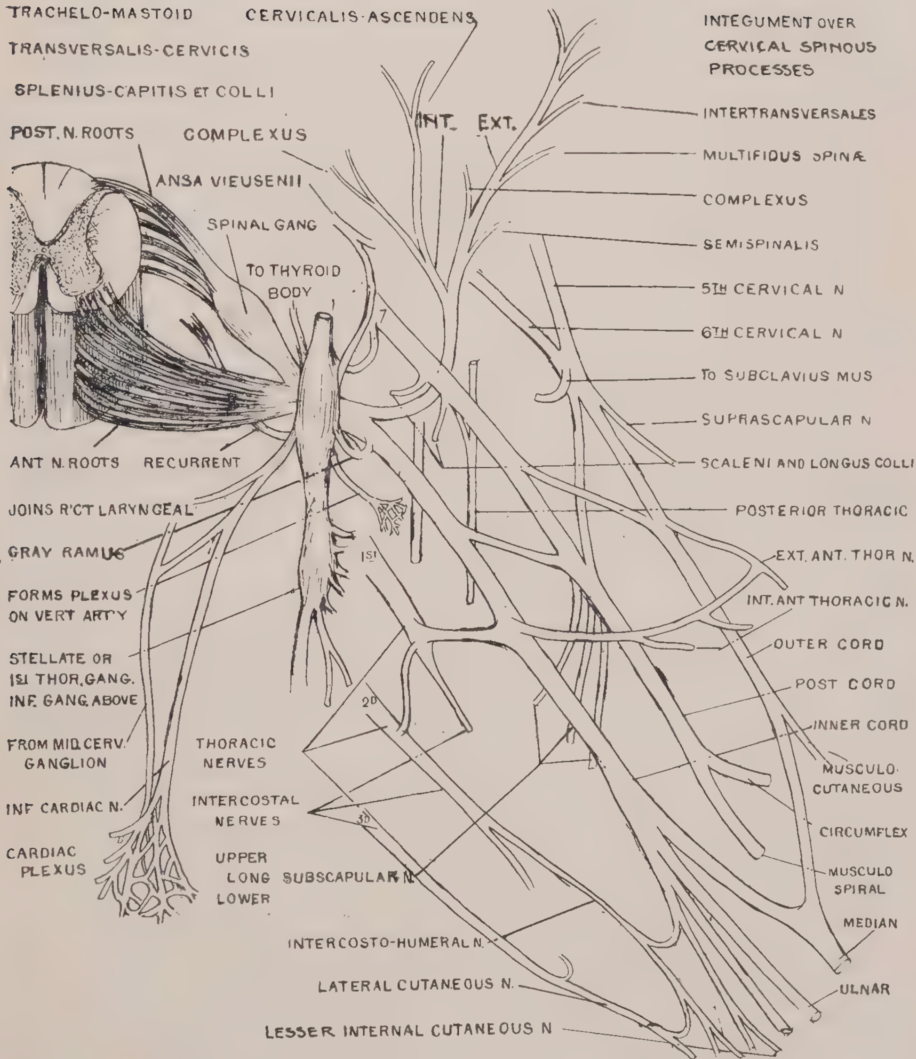

FIG. 30.—Showing the eighth cervical segment with its nerves and their distribution.

Not definitely knowing the kind and character of all the impulses carried by the grey rami, it would be impossible to describe accurately the effect of injury to them. Most all of the authors state that both afferent and efferent impulses are transmitted by the grey rami, but the efferent preponderate.

These efferent fibres carry vaso-motor impulses to the blood-vessels of the skin supplied by the nerves derived from the seventh cervical segment; secretory and pilomotor impulses to the same area. Perhaps a few sensory impulses from this area reach the cord by way of these grey rami.

The ansa subclavia supplies the subclavian artery, internal mammary artery and sends a communicating branch to the phrenic nerve. Some authors have described a branch from this ganglion that goes directly to the phrenic and clinically this seems to be the case. A lesion of the first rib will affect the phrenic and produce hiccough, and this branch seems to be the best explanation of the clinical fact in that the phrenic is affected through the inferior cervical ganglion. In dissections made and seen by the author, this communicating branch to the phrenic was quite often found.

As a result of a lesion affecting the ansa subclavia there would follow: (1) vascular disturbances in the parts supplied by these arteries, viz., arm, mammary gland and a part of the chest wall, and (2) derangement of function of all or a part of the structures supplied by the phrenic, viz., diaphragm, pleura, pericardium, peritoneum, heart and the diaphragmatic plexus.

The **recurrent laryngeal** nerve supplies motion to the larynx, hence the relation between lower cervical and upper rib lesions and throat affections, especially coughing. A better explanation of why lower cervical and upper rib lesions produce throat disorders is that these lesions affect the inferior thyroid artery by way of its nerve supply. This **artery supplies** to a great extent, the **esophagus, trachea, larynx,** the **deep muscles** of the neck and the **phrenic** nerve. If this artery is affected, congestion or anemia of these parts follows. Congestion leads to disordered secretions and other disturbances. Congestion in this case is due to vaso-motor inhibition which causes the vessels to dilate. This inhibition comes from a lesion that disturbs the middle or inferior cervical ganglion, since the vaso-motor impulses to this artery come by way of these ganglia, and especially the inferior. On account of this,

a lower cervical or upper thoracic lesion will produce vascular changes in the throat, hence the **hacking cough, catarrh, dryness** and disturbances of the voice.

The **heart** may be, and often is, affected by lesions affecting the inferior cervical ganglion and its cardiac branches. The impulses reaching the heart via the inferior cardiac do not, according to the best authorities, arise in the inferior cervical ganglion, but at a point in the spinal cord somewhat lower; the ganglion demudullating and otherwise changing the fibers. This cardiac nerve connects with the middle cardiac and inferior laryngeal nerves. This explains some cases of hacking cough accompanying and resulting from many forms of heart and lung diseases.

The **vertebral plexus** would also be affected by a lesion of the seventh cervical. This plexus sends **vaso-motor** filaments to the vertebral artery and all its branches, which control their size, hence the amount of blood passing through them. Thus the amount of arterial blood in the **cervical spinal** cord and **vertebral column, medulla, pons, cerebellum** and the posterior part of the **cerebrum** is governed to a marked extent by the condition of the vertebral plexus of nerves. As a result of this lesion almost any disease or disturbance of function of the parts supplied would arise, the principal one being eye affections. This is best explained by the fact that the centers for the eye, located in the floor of the fourth ventricle and the occipital lobes, are dependent to a great extent for their nutrition on the vertebral artery and its branches, while it in turn, is dependent on the healthy action of the vertebral plexus of nerves.

Not only the artery and its branches are supplied but the **vertebral veins** receive their vaso-motor impulses from this source.

The writer has seen cases of epilepsy, chorea and various circulatory disturbances of parts above result from a lesion of the seventh. A great majority of nerve fibers located in the inferior cervical ganglion have their origin lower, and transmit various sorts of impulses to parts above. Since nearly, if not all impulses reaching the head from parts below pass through this ganglion, it follows that any disturbance of it would in some way interfere with the transmission of these impulses, hence an effect in the points of destination. The inferior cervical ganglion, according to Quain, transmits pupillo-dilator fibers, motor fibers to the involuntary muscles of the eyelids and orbit, vaso-motor fibers

to the head and face, secretory fibers to the submaxillary gland, and accelerator fibers to the heart. All of the above fibers are supposed to originate in the upper thoracic portion of the spinal cord. The seventh and eighth cervical segments of the spinal cord contain pupillo-dilator fibers according to some observers.

Transverse myelitis often results from falls which dislocate or fracture this part of the spinal column. The thoracic vertebræ are fairly well fixed, hence the articulation between the seventh cervical and first thoracic vertebra suffers most because of the change of mobility which takes place at this joint. The writer has treated many cases of paraplegia caused by a lesion at this articulation which in most of them set up a myelitis.

Summary of seventh cervical. Lesions of this vertebra are associated with **affections** of the **upper extremity,** such as **pain, numbness, swelling, paralysis, sensory** and **motor,** and in short almost every form of disturbance of the upper extremity; **neck** affections, **eye** diseases, **headache, heart** disturbances, **throat** disorders, and especially vascular disturbances of any or all parts above this vertebra. Eye diseases are very often the result of a lesion in the lower cervical region. Progressive muscular atrophy, Erb's palsy, Duchenne's paralysis, clawed hand, wrist drop, "rheumatism" of the arm, neuritis and occupation neuroses result in many cases from a lesion of the seventh cervical vertebra.

In all neck lesions there is **tenderness.** This tenderness is most commonly **deep,** that is, in the **ligaments** and **deep muscles.** Occasionally it is superficial, that is, in the integument. It is most pronounced in the structures around the articular processes and is exaggerated by pressure. The **nerves** involved are the posterior divisions of the cervical nerves that supply the ligaments and deep muscles around the cervical vertebræ. The tenderness is due to **contracture** of the deep muscles attached to the vertebræ, **pressure** of the displaced bone directly on the nerve, **sprain** of the ligaments which takes place to a greater or lesser extent in all vertebral lesions or the tenderness is due to some **interference** with the **nutrition** of the cells located on the posterior nerve root. In most cases I believe that the tenderness is due to the injury to the ligaments, that is, the ligament is partly or completely torn, becomes congested and swollen and is affected in a way similar to that of a sprained wrist or ankle only to a lesser degree. The tenderness in a contractured muscle is due to mechanical pressure from the conges-

tion and to the chemical irritation from the toxic material which has formed in the muscle but has never been eliminated.

In the neck lesions the tenderness is found most frequently to be **over the spinous and articular processes** or at least in relation with these processes. It is present in many cases in which there is no bony displacement, the lesion in such cases being a ligamentous one. Manipulation of the joint will lessen it or even entirely remove it. This manipulation consists of passive movement of the joint, that is, the function of the joint is artificially restored.

THE REGION OF THE NECK.

The region of the neck. ' Anterior aspect. The **sterno-mastoid** muscle is the great muscular landmark of the side and front of the neck. Its degree of development and contraction determines to a great extent the contour and size of the neck. It is affected in lesions of the second and third cervical vertebræ and subluxations of the head on the spinal column. The angle of the chin, and the way the head is carried are determined by this muscle. It furnishes a reliable **landmark** for the **vagus** and **phrenic** nerves and the **carotid artery** and **jugular veins,** these structures being located immediately anterior to the middle portion of the muscle. Deaver says: "Its anterior border is the surgeon's guide in the ligation of the common, external and internal carotid arteries, the superior thyroid, lingual, facial and occipital arteries at their origin, and the inferior thyroid artery as it enters the thyroid gland; in exposing the spinal accessory nerve; upon the left side in the operation of esophagotomy, and in all other operations upon the front or the side of the neck." Torticollis is the principal disturbance of this muscle.

The **contour** of the central part of the anterior part of the neck is made irregular by the thyroid and cricoid cartilages. They are very movable, their position being altered in swallowing and in forced respiration. The **thyroid cartilage** is the more prominent and forms in many people, especially males with thin necks, a noticeable, angular prominence. It is of importance on account of its relation to the vocal cords.

The **cricoid** cartilage is immediately below and can readily be outlined. **Aphonia** follows displacement of, or injury to this cartilage.

The **hyoid** bone is located directly below the chin and its cornua can be distinctly outlined by pressure directed inward beneath the

angles of the jaw. Its position is determined by the condition of the various muscles attached to it. The vocal cords are in relation, or at least would be affected by malpositions of this bone. Aphonia is very commonly due to a displacement of it. It becomes displaced by colds, which cause the muscles to contract, or by direct trauma as in choking or other injury to the front of the neck. Its displacement may, in addition to that of producing aphonia and hoarseness, cause a chronic hacking cough, sore throat and dysphagia. In whooping-cough it is said to be displaced and that by drawing it forward away from the laryngeal nerves, the spasm of coughing can be prevented or at least lessened.

The **supra-sternal fossa** depends for its depth on the amount of adipose tissue in the lower part of the neck and the position of the clavicles. It is pathologically deepened in dyspnea as in asthma and tuberculosis of the lungs. In laryngitis, pressure in this fossa produces pain but gentle manipulation is beneficial.

The **supra-clavicular** fossa is the depression above the clavicle. When increased in depth it is symptomatic of tuberculosis of the lungs. It is also deepened in the emaciated and in the aged. When obliterated, it is indicative of a depressed clavicle unless the patient is obese. In tubercular patients this fossa and the adjacent tissues should be examined very closely by percussion and auscultation, since the apex of the lung, which is in relation, is the first part to be affected.

The **infra-clavicular fossa** is the depression immediately below the clavicle. It is of interest in that it is deepened in tubercular conditions of the lung.

The **platysma myoides** muscle is a superficial one which has to do with drawing down the lower lip and the raising of the skin and superficial fascia of the neck lying between the lower jaw and pectoral muscles. In some this muscle is remarkably developed, in others it cannot be outlined. It is of especial interest in that it is frequently the seat of a tic, the muscle undergoing spasmodic contraction every few minutes. The jaw is usually depressed and the shoulder raised and the face suddenly drawn into a peculiar expression. These movements are spasmodic. In such cases the cervical nerves instead of the seventh cranial, are most frequently involved.

The **skin** on the front of the neck is very **thin** in contrast to that on the back of the neck. Probably on this account, it is quite free from

eruptions. It is highly sensitive, being supplied in the main by nerves from the cervical plexus. The superficial vessels covered by it can ordinarily be outlined quite readily and the pulsations of the deep vessels can be seen if the pulsation is abnormally hard.

The **thyroid body** is a very vascular gland which is situated over the front and sides of the trachea and extending upward to the larynx.

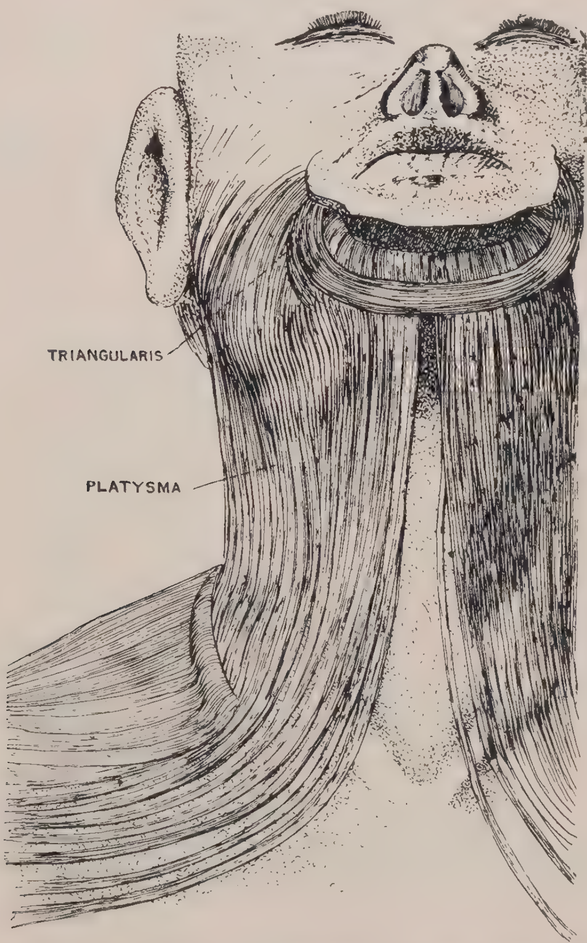

FIG. 31.—Showing the platysma myoides muscle. Note the direction of its fibers and their insertion on the face.

Fig 32.—Showing the platysma myoides muscle. (From photo).

It is composed of two lobes with an isthmus connecting them. It is of special interest because of enlargements or goitre occurring in it. Ordinarily the gland does not affect the contour of this part of the neck but when enlarged the gland can be plainly seen, this of course depending on the degree of enlargement. The gland varies in size in different individuals and at different periods in life. "It is relatively larger in the child than in the adult, and in the female than in the male." **Exophthalmic goitre** is rare in the male, common in the female. The causes of this disease seem most frequently to be lesions of the lower cervical vertebræ and upper ribs, such lesions affecting the circulation of the blood through and from the thyroid gland. The **arteries** are remarkable for their size, number and free anastomosis. They are the superior thyroid from the external carotid, the inferior thyroid from the thyroid axis of the subclavian, and the thyroidia-ima which comes from the aorta or innominate. From the above arteries it is ascertained that the sympathetic nerves to this gland are derived from the cervical sympathetic, the **superior, middle** and **inferior ganglia.** The inferior cervical ganglion clinically seems to be most frequently involved. Since the nerves to the thyroid are derived from the lowest part of the cervical and upper thoracic region, lesions of the lower cervical vertebræ and upper ribs, the first in particular, would affect it. The impulses reach the gland by way of the branches that surround the thyroid arteries.

The **veins** of this gland are also large and very numerous, forming a plexus which is drained by the superior and middle thyroid, which empty into the internal jugular, and the inferior thyroid which empties into the innominate vein. A displacement of the first rib, it usually being backward and downward at the sternal end, upward and backward at the vertebral, will directly or indirectly produce pressure on these veins. A subluxated clavicle will in a similar way interfere with drainage.

Atrophy or lack of development of the gland will produce **myxedema;** in children, **cretinism** or idiocy.

Aneurism of the arch of the aorta or carotid arteries may change the contour of the anterior part of the neck.

The **trachea** is located immediately below the cricoid cartilage, it being about one and a half inches above the sternum. It can only be seen when the neck is in extreme extension. The trachea is sometimes opened to relieve dyspnea, as in croup.

The **vessels** that can be **seen** in the anterior part of the neck are the superficial veins that stand out so very boldly in many patients during exertion, especially if the breath is held. The posterior and external jugular are the most important. Experiments have been performed in which oil was injected into the pericardial sac. In such cases it was found that the superficial veins of the neck became distended. Clinically in cases in which there is a pericarditis or pleural effusion by which the right auricle is compressed, the superficial veins of the neck become distended. The explanation is that the venous return is obstructed, to a certain extent, by the pressure on the heart, and the blood is forced back along the veins and the effect is most marked in the superficial because they are not supported by muscles as are the deep veins. In some types of organic disease of the heart, pulsation of the superficial veins of the neck is quite noticeable. I have noticed that children suffering with sore throat or tonsillitis often have enlargement and distension of the veins of the neck.

The **carotid arteries** can be palpated and the pulsation, if unusually hard, can be seen. Such latter pulsations of the carotid arteries are very suggestive if not diagnostic of some form of heart disease.

The **lymphatic glands** of the neck are often very much enlarged, so that the contour is decidedly changed. Scrofula, tonsillitis or disease of any part drained by the anterior cervical lymphatic glands will cause their enlargement. In ordinary sore throat "kernels" form under the angle of the jaw. Lesions of the neck sometimes produce these enlargements. Tuberculosis is the common cause of chronic enlargement of these lymphatic glands, especially if the enlargement is marked. Tonsillitis produces an enlargement or swelling immediately anterior to and below the angle of the jaw. This swelling or rather fullness, is always present in chronic tonsillitis, therefore a fullness under the angle of the jaw is almost diagnostic of disease of the tonsils or of adenoid growths in the throat. Chronic tonsillitis predisposes to tuberculosis of the lymphatic glands of the neck in that the tubercle bacilli enter the crypts of the tonsils, thence into the lymphatic glands that drain the tonsil. The lowered vitality of these glands permits the micro-organisms to gain a footing in the body, and soon the patient has scrofula. The kernels increase in size and finally an abscess forms. On this account, children suffering with chronic sore throat or especially tonsillitis, should be treated early and thus prevent infection through the tonsils.

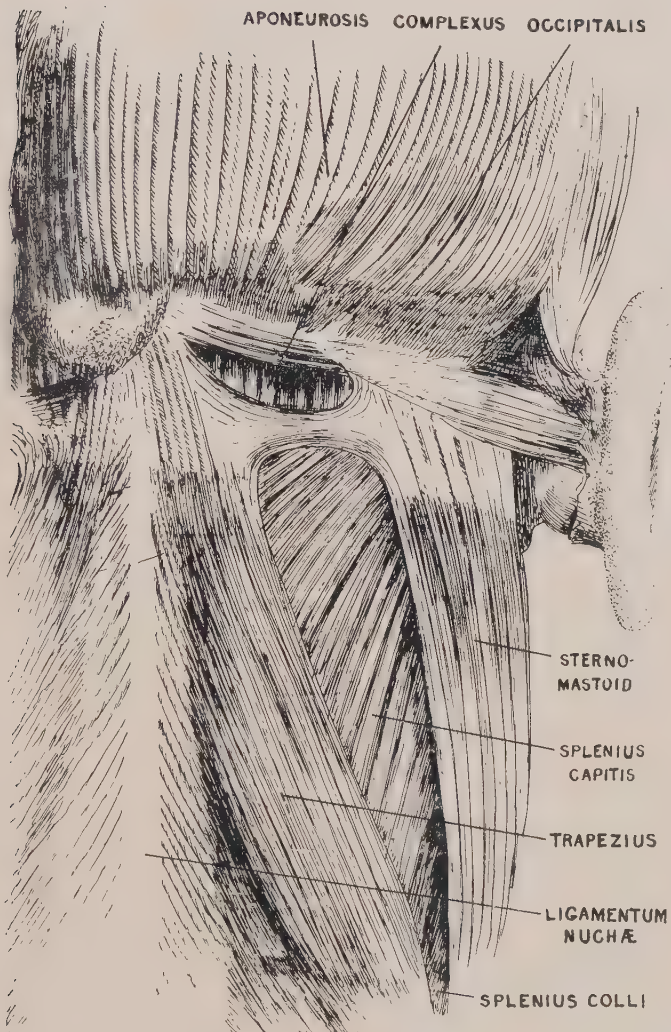

FIG. 32.—Showing the relation of the superficial muscles of the upper part of the back of the neck. These are first to be affected by thermic influences as in the catching of cold in the head.

Tuberculosis may be the cause as stated above of these lymphatic enlargements, but in all probability it is the result of the infection that reached the glands through the throat and tonsils.

The **nerves** that are in relation with the superficial structures of the front of the neck are the vagus, and phrenic. These nerves are sometimes treated for a palliative effect by pressure directed over their course. In **hiccough** the phrenic is inhibited; in disturbance of structures supplied by the vagus, this nerve is either stimulated or inhibited by manipulation of it along its course. Such treatments are not curative and not always palliative, **and are only advised when no better treatment can be given.** Pain near the angle of the jaw is usually in the inferior division of the fifth cranial. Pain in the median line or near by is suggestive of laryngitis. Pain in this region is seldom a referred one in the sense that it is the result of disorder elsewhere, it being due to direct involvement by some local disturbance. The cause of greatest pain in the front and side of the neck is some form of tonsillitis. Acute laryngitis and diphtheria also produce marked pain in this region.

The **contour** of the **back of the neck** is governed more by the condition of the trapezii than by any other one factor. These muscles form a furrow, the median furrow of the neck, along which the spines of the cervical vertebræ, with the exception of that of the atlas, can be readily palpated. The trapezius is contracted in colds in the head, uterine headache, spinal meningitis and headache from weakness or other disturbance of the eyes and is quite tender when contractured. This tenderness is possibly due in part to the fact that the muscle is markedly congested when contractured. To the other or outer side of the insertion of this muscle is a fossa, the **sub-occipital fossa,** which is a very important place from an osteopathic viewpoint, because the articular processes of the cervical vertebræ can be palpated along the furrow leading down the neck from it. **Tenderness** in the sub-occipital fossa is almost diagnostic of an upper cervical lesion. In such cases deep palpation reveals muscular contractures and a general tightness in the upper cervical region. Pressure at this point, applied by means of the fingers, is the usual palliative treatment for headache. **Headaches** caused by an upper cervical lesion can be relieved by such a treatment. By deep pressure applied to this point is secured adjustment of the vertebral articulations and relaxation of the contractured tissues.

The best place to apply this pressure in the treatment of headaches

is in the median line immediately below the occiput. By applying it here the occiput is pried slightly off the atlas and the circulation to and from the head freed, to a certain extent. This is an especially effective treatment in cases in which the headache is due to a tightening of the cervical tissues, that is in cases of congestive headache, especially the form due to disorders of the eye, such as eye-strain.

In **lesions** of the cervical vertebræ, the irregularity can best be determined by palpation along the above mentioned furrow. The articular processes are changed in position in lesions affecting the bones; the articular processes are in relation with this furrow, hence in suspected lesions of the neck, **carefully palpate over the articular facets.**

The **bony landmarks** of the neck are the transverse processes of the atlas and the spinous processes of the second and seventh. The third may be regarded as a landmark since its spine is furthest anterior. The greatest movement exists at the atlanto-axial articulation. Mobility is also quite marked at the third cervical, it being subject to dislocations. It is also subject to fracture, at least it is most frequently fractured of the cervical vertebræ. **Always test for mobility of the various cervical articulations.** This is best done by grasping and holding the neck at points corresponding to the different articulations and then with the other hand move the head in various directions.

The **skin** of the back of the neck is very thick and the circulation through it more sluggish than through the vessels of the skin of the front of the neck. On account of this fact and that it is subject to friction from the clothing, this part of the neck is subject to boils and carbuncles. This is also true of the integument covering the upper part of the back and shoulders, also that of the gluteal region.

The **temperature** of the back of the neck is indicative of the condition of the tissues beneath the skin. The condition of these tissues determines the condition of many of the organs and structures above, especially the mucous membrane lining the nasal fossa. If the back of the neck is **cold,** it indicates a condition of low vitality of the part which is most frequently the result of cervical lesions. Such conditions are followed or accompanied by catarrh. The catarrhal effect will come in a few minutes after sitting with the back of the neck exposed to a draught. **Coryza** is the result. The explanation is that the thermic stimulation readily affects the neck if the part is weakened by cervical lesions, thereby setting up muscular contractures. These contractures

affect the centers controlling the amount of blood to the head, especically the nasal mucous membrane. The impulses are so interfered with that congestion follows in a very short time, which congestion is manifest first by a sense of tightness followed by a "running of the nose." **If the patient can sneeze, often the cold will be aborted.** These vaso-motor centers are located in the upper thoracic segments and the impulses pass through the superior cervical ganglion, from which they pass up through the ascending branches to the fifth cranial nerve, thence to the vessels of the nasal mucous membrane. The contractured cervical muscles prevent, or rather interfere with, the normal amount of impulses. The conclusion is, **keep the back of the neck warm all the time** and the probabilities are that colds in the head can be prevented. To do this, correct all cervical lesions that so weaken the neck that a slight draught will affect the muscles thus made abnormal. If this is done, every little change of weather and exposure to draughts will not cause coryza or make the catarrh worse. Also be careful about needlessly exposing the back of the neck to a draught. Nature attempts to prevent this by causing the hair to grow long. We destroy nature's fortifications by wearing the hair closely cropped, as in the male, or knotted or rolled up on top of the head as does the female.

The back of the neck is subject to many changes from **atrophy** or **enlargement** of the parts composing it, or from deposits or new growths. The muscles, as mentioned above, are subject to contracture. The trapezius is affected in curvatures of the spine, hip dislocations; in short, from limping from any cause, if chronic. In torticollis the sides are not symmetrical. In hemiplegia the neck muscles are involved. Thickening of the muscles may take place without affecting the contour of the neck. In all head and throat affections, some of the posterior muscles of the neck are always thickened, the obliqui, splenii, trachelomastoid and multifidus spinæ being most frequently contractured.

The **ligaments** become thickened from lesions of the articulations. The **thickening is most marked** on the **convex** side. A thickening on the left side over the articular process would indicate that the ligaments had been partly torn by **extreme flexion to the right side.** The **tenderness** will be on the **left.** This explains unilateral tenderness from vertebral lesions. If tenderness is about equal on each side, it indicates stretching of both sides, that is, the lesion resulted from extreme flexion or extension of the neck. The unilateral thickening or enlargement is by far the more common.

The **lymphatic glands** along the sides of the neck become enlarged from causes similar to those producing enlargement of any lymphatic gland: scrofulous conditions or formation of toxic material in area drained by the gland.

The neck is the seat of many kinds of aches and pains. In most cases the patient is not aware of possessing so many tender places in the neck until an examination is made by palpation. Tenderness under the occiput in the median line is indicative of eye affection. Tenderness over the **articular processes** is almost diagnostic of subluxation of the vertebra or injury of the ligaments. Superficial tenderness or hyperesthesia is an accompaniment of recent injuries, meningeal affections and lesions affecting the sensory innervation. Tenderness and pain are increased by pressure, tightening of the muscles from the catching of repeated colds, improper treatment of the neck, such as a sudden and unexpected twist or pull, and disturbances of the spinal cord.

The **neck as a region** is more subject to injury than any other part of the body. This is on account of its free mobility, exposed position and its size. Childbirth, improperly handled, is responsible for many cases of idiocy, paralysis usually of the spastic type or Little's disease, monstrosities and various deformities of the head and body. Too much or improper traction is used. Forceps are unnecessarily applied. Force is used in a wrong direction, the neck twisted and traction exerted during rotation of the head, and the neck is injured. The child's mental and physical development are retarded and the trouble is attributed to heredity. There are cases of hydrocephalus, microcephalus, spastic paraplegia; retraction of the head, inability to talk, Little's disease, non-control of movements of limbs, diseased gums with crumbling teeth and many other forms of disease that, in the author's practice, were found to be the result of injury at delivery.

Dr. Still has called my attention to the improper extraction of teeth, in many cases, as a cause of neck lesions. The strain, the position, the force, the sudden jerk that accompanies or follows extraction, all tend to injure the neck, for it bears the brunt of the strain.

There are many other causes, such as colds, a sudden turn of the head, improper treatment, occupation and the various injuries to which the neck is subjected. The parts of the neck most frequently affected are the atlanto-axial articulation and the articulations of the third cervical, the points of greatest mobility and weakness.

Many disorders of the cervical region are the result of lesions lower in the spinal column. A lesion in the upper thoracic region will cause contracture of the cervical muscles which in turn, interferes with movement of the head and neck. In some cases seen by the writer, there was a constant pain in the cervical region as a result of a lesion of the fourth dorsal vertebra. The pain started from the point of lesion but was greatest in the upper part of the neck. Perhaps most of these secondary cervical disorders are the result of muscular contracture, while some are due to direct interference with the innervation of the neck. The point to be remembered in this connection is, that the lesion is not always at the point of pain or where the effect is, but often at a place somewhat distant from the manifest effect.

The effects of these lesions are manifold. The special senses, brain, face, throat, arms and the neck itself are involved. The kidneys may be affected, or a spinal curvature may result from a neck lesion as was the case in a patient seen by the writer. Most of the diseases of the head, face and throat have been considered with the discussion of effects of lesions affecting the superior cervical ganglion. Some of the arm affections have been described. In addition to those mentioned there might be named the occupation neuroses, Erb's paralysis, wrist drop, progressive muscular atrophy, contractures and deformities of the forearm, wrist and fingers, and the painful disturbance usually, called neuralgia. In all occupation neuroses seen by the author in which the upper extremity was involved, a neck or thoracic lesion was found. These lesions weaken the arm and act as predisposing causes; the occupation is the exciting cause. If the occupation were the only cause there would be many more cases of telegrapher's cramp. As it is, only a very small per cent of telegraphers are attacked. The same is true of the other occupation neuroses. To cure such cases, remove both the predisposing and exciting causes; that is, correct the neck lesion and advise the patient to rest.

Erb's paralysis involves the upper arm and shoulder, at least the effect is there. Neck and upper thoracic bony lesions disturb the origin, exit and nutrition of the nerves which supply these parts, hence the effect. These lesions change the size of the intervertebral foramina, which must of necessity affect the vessels and nerves that pass through them. This effect may be motor, sensory, secretory, vaso-motor or trophic. The conclusion is that in any or all effects in the upper ex-

tremity the cause lies in the spinal column, especially the cervical and upper thoracic portions, unless the trouble is due to trauma whereby the nerve trunk is directly injured. Occasionally, the nerve is affected by a dislocation of the shoulder, elbow or wrist, so it is well to **begin at the point of disturbance and follow the course of the nerve back to its exit from the spinal canal** since in this way it is easier to locate the lesion.

THE THORACIC VERTEBRÆ.

The **dorsal** or **thoracic** vertebræ being typical vertebræ, consist of two parts, a body and an arch. The body is not quite circular but somewhat heart-shaped, it being wider transversely than antero-posteriorly. It is concave above and below, in which concavities fit the intervertebral discs. The bodies are somewhat concave from above downward and are slightly beaked. The front surfaces are perforated for the passing in and out of the various blood-vessels, the smaller transmitting the nutrient arteries, the larger the veins (the venæ basis vertebrarum).

The **arches** give rise to seven processes. The **spinous** project backward and downward and can be seen in most patients. The two **transverse** processes project outwardly, are quite thick and terminate in a **clubbed** extremity. Each articulates with the corresponding rib. They give attachment to many muscles and furnish a powerful leverage to them.

The **two superior articular processes** project upwards and bear **facets** which project or rather face backwards, slightly upward and outward.

The **inferior facets** face directly opposite to the superior. The **laminæ** are continuous with the spinous processes and complete the arch posteriorly.

THE FIRST THORACIC.

The **first thoracic** is a transitional vertebra, in that it resembles the cervical and thoracic types. Its spine is usually more prominent than that of the vertebra prominens. It is thick, very strong and in position is almost horizontal, projecting slightly downward. The superior facets are almost flat and face backward, slightly outward and upward.

The **articular processes help to form the foramina,** on which account the **least change** in their position would affect the **size of the foramina** formed by them.

The **transverse processes** are typical of those of the other thoracic vertebræ and have facets for articulation with the first ribs. The facets on the transverse processes face slightly upward, thus giving a better support to the upper ribs. The body has two facets on a side for articulation with the heads of the ribs; the upper one is entire, the lower a demifacet.

The **movements** of this vertebra are slight, rotation being, perhaps the most pronounced. Flexion and extension are present but to a very slight degree.

Lesions of various types are found affecting the articulations of this vertebra. The vertebra is subject to anterior, posterior and twisted conditions, this being determined by the character of the lesion. The **effects** of lesions involving this vertebra, that is, the articulation with the seventh cervical or with the second thoracic, depend on the degree of disturbance of structures attached to it and the amount of **change in size** of the intervertebral foramina.

The **indications** of a lesion of the articulations of the first thoracic vertebra are **tenderness** over and around the spine, **irregularity** of the spine, it being out of line or approximated to one above or below, and **disturbance of function** of that part of the spinal column or of the viscera innervated by the upper thoracic spinal cord.

The **effects** of a lesion on the articulations are similar to effects from other vertebral lesions, that is, a thickening of the tissues attached, the ligaments being congested or inflamed, hence tender. The **supraspinous** ligament is always affected in chronic cases, it becoming **softened** and **thickened** and quite smooth, sometimes entirely filling the space between the adjacent spinous processes.

The important **muscles** attached to the first thoracic vertebra, hence necessarily involved by a displacement of this bone, are the **levator costæ, serratus posticus superior, multifidus spinæ, rotatores spinæ, spinalis dorsi, transversalis colli, trachelo-mastoid** and **complexus.** All of these have been considered with the exception of the rotatores spinæ and levator costæ.

The **levator costæ** muscle arise from the transverse processes of the vertebræ and is inserted into the rib below at a point between the angle and tubercle. The lower ribs receive two slips. The **function** of the muscle is, as its name indicates, to elevate the rib, that is to assist the external intercostals. The **blood-supply** is derived from the inter-

costal arteries in relation. The **nerve** supply is from the intercostal nerves that are in relation. Contracture of this muscle causes a displacement of the ribs. In the upper thoracic region this is most frequent, and thus there is a predisposition to lung affections. In all cases of acute lung disease, these muscles are in a contractured state, while in the lung affections characterized by wasting and atrophy these muscles are atrophied as in tuberculosis of the lung.

The **rotatores spinæ** muscles, as their name indicates, have to do with rotation of the spine, a rather important movement of this region. A disturbance of their function would result in impaired movement, that is painful or otherwise disturbed rotation, of this part of the spinal column. Their fibers run from above downward and outward and can be palpated when contractured. As a result of a lesion of the first thoracic vertebra the position and movement of the ribs would become pathological, and flexion, extension, lateral flexion and rotation of this part of the spine would be interfered with, the movements being restricted or painful.

The **spinal column** would be weakened at the point of lesion. **Fatigue** would be first and most marked at the first thoracic, if it were subluxated. **Colds** would settle at this place and the patient would be conscious of a weakness in this region. This weakness has a tendency to produce change in contour of this part of the spine, flattening being the common change.

The lower articulations of the thoracic vertebræ will be considered instead of the upper as was the case in the cervical vertebræ; this is done in order to make the nerve correspond in number with the vertebra. Only one articulation will be considered with each vertebra.

The **first thoracic** vertebra articulates with the second by two facets and the body. Two foramina are formed through which pass vessels and nerves. I believe that nearly all diseases caused by vertebral lesions are the result of a lessening in size of the intervertebral foramina. **Every vertebral lesion causes a lessening in size of either the foramina above, or below** the affected vertebra. This affects the structures transmitted by the foramen.

The **veins** passing through the intervertebral foramen between the first and second thoracic vertebræ, are the lateral spinal. They drain the vertebra, meninges and especially the first thoracic segment of the spinal cord. This vein follows the sheath of dura mater that surrounds

the first thoracic nerve. It is joined by the vein draining the muscles in relation. The vein thus formed empties into the upper superior intercostal vein, which in turn empties into the vertebral or innominate. An obstruction to the intercostal or spinal veins would produce passive congestion of the parts drained, viz., muscles, vertebra, ligaments, meninges and spinal cord.

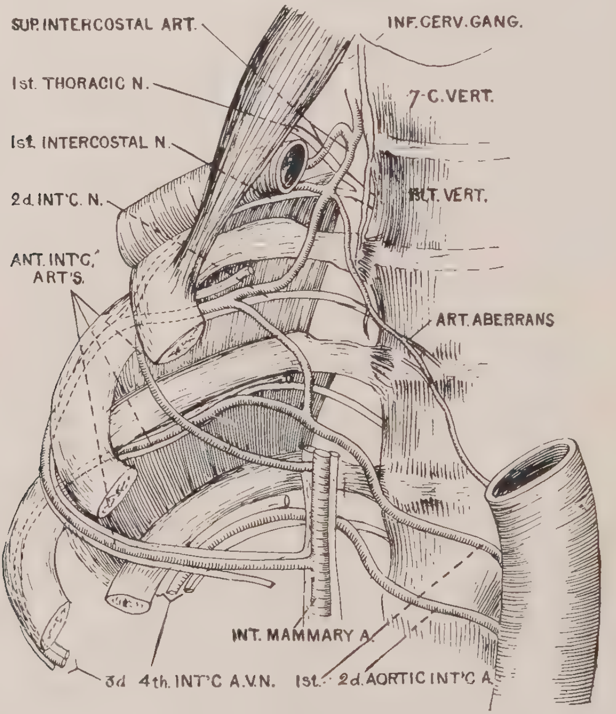

FIG. 34.—Showing the upper intercostal arteries and their anastomoses and branches. Note their relation to ribs.

The **lateral spinal artery** passing through the foramen below the first, is derived from the superior intercostal which is a branch of the subclavian. The nerve supply of it is derived mostly from the subclavian plexus. The lateral spinal branch divides into three branches, one going in front of the body of the vertebra, called preneural; one going to the back of the spinal canal, or retro-neural; and a middle branch

which supplies the spinal cord and anastomoses with the anterior and posterior spinal arteries from the vertebral. The nutrition to these parts to which the artery is distributed will suffer to some extent, if the arteries are compressed even though there is a fairly free anastomosis. This would be the case in a subluxation of the first thoracic vertebra.

The **nerves** passing through the first thoracic intervertebral foramen are the **first thoracic nerve** and the **recurrent meningeal.** The first thoracic carries many impulses to and from the spinal cord.

They are composed of filaments that carry **vaso-motor** impulses to the head, neck, arm and shoulders and integument; **secretory** to many of the glands above; **motor** to the muscles supplied by this segment and the involuntary muscles of the orbit and to the heart; **sensory** to to the viscera and integument supplied by this segment; and **trophic** to the various structures named above. The impulses distributed by the cervical sympathetic ganglia come from the upper thoracic spinal cord, hence a part of them pass over the first thoracic nerve, that is, through the first thoracic intervertebral foramen. On account of this peculiarity Hulett, in his Principles of Osteopathy says: "The general statement is not far wrong that any disorder produced by a cervical lesion may be duplicated by an upper thoracic disturbance."

The **first thoracic** nerve divides into an anterior and posterior division. The anterior, gives rise to the **internal anterior thoracic, internal cutaneous, lesser internal cutaneous** or **nerve of Wrisberg, ulnar, median** and **first intercostal.** The posterior divides into the **internal and external branches.**

The **internal anterior thoracic** is of importance on account of supplying the pectoral muscles. A disturbance of this nerve would cause atrophy or other effects in these muscles, hence impairment of movement of the arms and chest.

If the **internal cutaneous** nerve is involved by a lesion of the first thoracic, there will be sensory disturbances along the inner and anterior part of the forearm as low as the wrist and also along the inner and upper part of the arm. It is a sensory nerve.

If the **nerve of Wrisberg** is involved there will be pain or other sensory disturbances over the olecranon process and a part of the inner aspect of the lower part of the arm. On account of this nerve communicating with the intercosto-humeral nerve, the sensory disturbance may be referred to the upper two or three intercostal spaces, or a lesion af-

fecting the intercosto-humeral may cause the sensory disturbance to be referred to the lower part of the arm and elbow. The **ulnar** and **median** nerves have been discussed above.

The **smaller division of the first thoracic nerve** continues along the first intercostal space as the first intercostal nerve, and supplies the intercostal muscles and pleura in relation. It seldom supplies the integument over the first intercostal space, the lateral cutaneous branch being absent. It occasionally communicates with the lesser internal cutaneous and the intercosto-humeral.

The **internal** branches of the posterior division of the first dorsal nerve supply the integument in relation; the **external** supply the muscles in relation. These nerves are reflexly affected in bronchial, throat and lung affections as is evidenced by the sensory and muscular disturbances. Pain over the parts supplied by the posterior division of the first thoracic nerve is indicative of (1), lesion of the first thoracic vertebra or first rib, or (2), disease of the upper part of respiratory tract as in colds, bronchitis and la grippe.

The **first thoracic nerve** controls, in part at least, **flexion** of the fingers, **pronation** of hand, **forward** movement of the arm and shoulder, movements of the upper ribs through action of the levatores costarum, serratus posticus superior and intercostal muscles, extension and lateral flexion of the upper part of spine. The motor effect of impairment of this segment from a lesion or from hemorrhage or inflammation (myelitis), would be most marked in the muscles of the hand, back and upper part of chest. The rib muscles acting symmetrically would be little if any affected unless both sides of the cord were involved. These muscles are rarely paralyzed either by hemorrhage in the brain, as in hemiplegia, or in the spinal cord as in anterior polio-myelitis.

The first thoracic controls the sensory condition of the ulnar aspect of the forearm, inner side of the upper arm, the integument of the back in relation with the first thoracic vertebra, and the first intercostal space.

The **recurrent nerve,** which is vaso-motor to the arteries in relation supplying the vertebræ, ligaments, meninges and spinal cord, would be involved by a lesion of the first thoracic.

The **stellate ganglion,** which is in relation with the first thoracic vertebra, will be affected in some way by a lesion of this vertebra. This ganglion is irregular in form, slightly larger than the other thoracic ganglia and often coalesced with the inferior cervical ganglion. It is

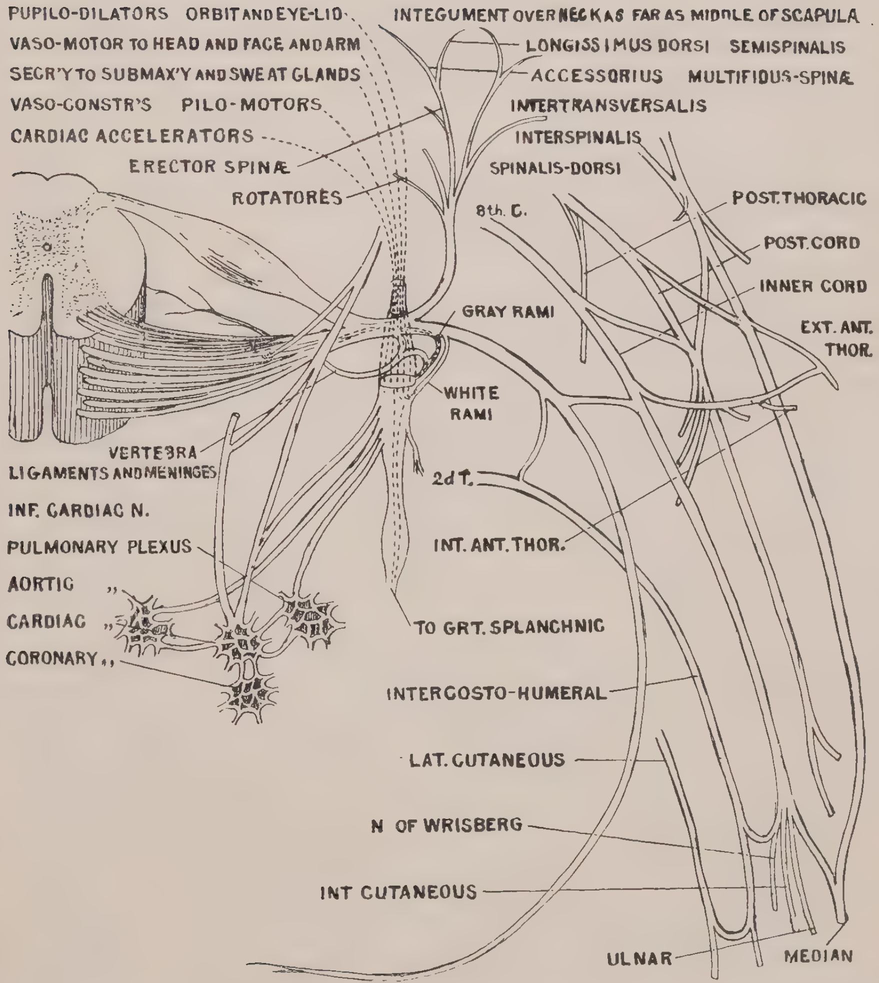

Fig. 35.—Showing the first thoracic segment of the spinal cord with its nerves and their distribution.

situated immediately in front of the head of the first rib and is in relation with the pleura and the superior intercostal artery. It is connected with the ganglion above and below by the sympathetic chain and gives off the following branches: Filaments to the first dorsal vertebra and its ligaments, the thoracic aortic plexus and to the lungs and the grey ramus communicans. This ganglion transmits all vaso-motor, secretory, trophic, and possibly motor impulses destined for the parts above, or at least all impulses arising in the thoracic spinal cord pass through this ganglion on their way to the head and face. Some cells are located in the ganglion but its function seems to be that of transmission of impulses rather than that of originating them. Brubaker says that, in the cat, cutaneous nerves for the fore-limbs have their origin from cells in the stellate ganglion (first dorsal).

The **white ramus communicans,** which is usually present, passes from the anterior division of the first thoracic nerve to the stellate ganglion, thus carrying impulses from the spinal cord to the gangliated cord. Some of the fibers come from the posterior root. The gangliated cord generates some impulses, at least motor impulses, but the cells are mostly in the grey matter of the spinal cord. Quain says: "Some of the medullated fibers are continued over the ganglia of the cord to enter the efferent branches; others end in the ganglia, often ascending or descending for a considerable distance in the cord to reach ganglia at a higher or lower level than that of the communicating branch by which they pass to the sympathetic." These fibers are not confined to one ganglion, sometimes passing to several ganglia above or below. The white rami therefore transmit to the gangliated cord, impulses generated in the spinal cord, some of which pass up, some down the gangliated cord, others passing directly through, thus forming the rami efferentes. The white ramus passing from the first thoracic nerve to the stellate ganglion carries **pupillo-dilator** impulses, and impulses to the **involuntary** muscles of the eyelids and orbit, **vaso-motor** impulses to the head and face, **accelerator** impulses to the heart and **secretory** to some of the salivary glands.

The pupillo-dilator fibers originate in the upper thoracic segments of the spinal cord and pass out over the white rami into the gangliated cord, thence up the cord to the superior cervical ganglion, thence over the ascending branches to the third and fifth nerves. These impulses may arise as high as the seventh cervical and as low as the fourth thoracic. Lesions affecting these segments or the white rami, will interfere with

the origination or transmission of these impulses, hence an effect in the parts supplied, that is the pupil. Contraction of the pupil may follow injuries to the first thoracic vertebra when these nerves are affected.

The **centers** for the **involuntary muscles** of the orbit and eyelids are also located in these segments and the impulses reach their destination in a similar way. **Strabismus** often results from a lesion of the first thoracic vertebra. The vaso-motor, or the above nerve connection will explain it. Some claim that the voluntary muscles of the eye receive impulses from this part.

Disturbance of the ciliary nerves is a common effect of this lesion. Blepharospasm, pain in the eyeball, weakness of the eyes, photophobia, conjunctivitis, and in fact almost any vascular disturbance of the orbit and eyelids results from a lesion of the upper thoracic vertebræ, the first in particular. The explanation is that the various impulses for the eye, especially motor and vaso-motor, originate in the upper thoracic spinal cord or there are subsidiary centers there and these impulses pass over the white rami to the gangliated cord, thence through the cervical ganglia to the nerves supplying the eye. Lesions of the first thoracic affect both the segments and rami, and hence interfere with the centers and the nerve tracts conveying the impulses. This has been practically proven in three ways: (1) by physiological experiments on lower animals; (2) by dissection and (3), most important of all, **clinically by taking cases with the diseases, correcting the upper thoracic lesions and curing the diseases.**

The **vaso-motor** centers for the **head** and **face** are also located in this region. It is possible and quite common for upper thoracic lesions to produce vascular effects in the head, congestion being most common. The writer has relieved many cases of headache by correcting a lesion of the first thoracic vertebra. The explanation of such lesions affecting the head is that they interfere or alter in some way, the passing of these impulses; they, originating in the upper thoracic segments of the spinal cord, pass out over the white rami to the gangliated cord thence up the cord to the vessels of the head and face.

The **accelerator impulses** to the heart are transmitted in part by the white ramus of the first thoracic nerve to the sympathetic gangliated cord in relation, thence directly across to the cardiac plexus or up the gangliated cord to the cervical ganglia, thence out over the cardiac branches. Clinically most of these fibers emerge from a point lower in

the spine, the fourth dorsal foramina being the most important. Congestive headaches are often the result of cardiac disturbances. A lesion of the first thoracic vertebra may affect the heart, hence an effect is in the head. Congestive headaches may thus result from a disturbance of the vaso-motor nerves to the head or from heart affections. The upper thoracic lesions will affect both.

The **grey rami communicantes,** as in the cervical region, arise from cells located in the sympathetic ganglia and pass to the anterior primary division of the corresponding cerebro-spinal nerve. After reaching the nerve Quain says that "the fibers are directed both peripherally and centrally. Of those passing centrally some go off in the posterior primary division of the nerve, others enter the sheath of the nerve, the surrounding tissue in the intervertebral foramen, and the dura mater, running up to the latter in the posterior root." The fibers passing distally in the anterior and posterior primary divisions of the spinal nerves have been shown, by experiments on animals, to supply "vaso-motor nerves to the arteries of the body-wall and limbs, pilo-motor fibers to the muscles of the hairs, and secretory fibers to the sweat glands." Lesions of the vertebræ and ribs affect the grey rami.

A lesion of the articulations of the first thoracic vertebra will affect the first dorsal ramus. As a result of this there are vaso-motor effects in the body-wall in relation, vertebræ, ligaments, meninges and spinal cord, and secretory effects in the sweat glands. The predominating sweat centers seem to be located in the upper thoracic region, thus a lesion there will lessen or increase the amount of perspiration.

It seems that the spinal nerves, through filaments that pass through the sympathetic gangliated cord, control or supply the viscera with **sensation.** Quain says: "There is strong reason for believing that the thoracic and abdominal viscera are supplied with sensory fibers derived from the spinal nerves, and passing through the sympathetic." These fibers pass from the posterior root to and through the sympathetic gangliated cord without interruption, to the viscera. This then offers an explanation for referred pain. Head, after experimenting on animals and from inferences drawn from clinical observation in man, formulated a law, the substance of which is that a **stimulus applied to an area of low sensibility in close central connection with an area of high sensibility may result in pain being felt in the area of high sensibility.** As an illustration, an irritation of the heart will produce pain in the chest wall

over the heart. Sympathetic nerves supply areas of low sensibility, cerebro-spinal, areas of high sensibility. According to Head, the heart and lungs are supplied in part with sensation by nerves that come through the first thoracic foramen of the spinal column,that is by the first thoracic nerve. The impulses pass over the sympathetic to the white ramus, thence over the posterior nerve root to the spinal cord. Diseases of the heart and lungs affecting these sensory nerves would cause pain to be felt that is referred to the areas supplied with sensation by the upper thoracic nerves, in this case, the first. The impulses from the heart and lungs, and those from the areas supplied with sensation by the upper thoracic nerves pass through the upper thoracic segments of the spinal cord thence over a common tract to the sensorium. According to Head's law, the sensorium is often mistaken as to the source of the impulses and refers them to the areas of greater sensibility. This seems very plausible since all of the sensory impulses from the above region pass through the upper thoracic segments of the spinal cord. As a result of this confusion of impulses, the pain in **heart affections** is referred to the **chest-wall** and **left** arm, especially the ulnar aspect. In **lung affections,** it is referred to the intercostal nerves that are derived from the same segments of the spinal cord that supply the lung. The **conclusion** that we are forced to draw, is that the segmental innervation of viscera can be accurately determined by noting the points of pain in disease of the viscus, that is by noting the cerebro-spinal nerve that is the supposed seat of the pain. To illustrate, if the heart is affected and the pain is referred to the fifth intercostal nerve, the fifth thoracic segment of the spinal cord is the one that gives origin to the nerves of the heart, especially do the sensory impulses pass through this segment on their way to the sensorium.

In quite a large per cent of all cases of angina pectoris, there is pain or numbness of the little and ring fingers of the left hand. The explanation as stated above is that that the sensory impulses from both the hand and heart pass through the same segment and there arises a confusion as to the source since normally, such impulses come entirely from the arm and chest wall.

Summary. Lesions of the articulations of the first thoracic vertebra produce eye, brain, arm, bronchial, lung and throat disturbances. In colds, the articulations of this vertebra are invariably involved either primarily or secondarily through muscular contractures. Lesions of

this bone produce pain in arm, chest and upper part of spine, muscular contractures in the interscapular region, impaired movement of the fingers, arm and spine and disturbances of sweat secretion in this area. The thoracic aorta, coronary and bronchial vessels and the splanchnic nerves may also be involved.

THE SECOND THORACIC.

The **second thoracic vertebra** is very similar to the first except that it has two demi-facets for articulation with the ribs, instead of an entire facet and a demi-facet. It is a typical thoracic vertebra. The spinous process is a little more oblique than that of the first. The **movements** of its articulations are very slight. **Rotation** is said to be the most marked of these movements, although flexion and extension are also represented. The **superior facets** face backward, slightly outward and upward, the surfaces being nearly flat. The inferior, face the opposite way. The most common lesion is a lateral deviation if the second alone is affected, but if several of the upper thoracic vertebræ are involved, the most common lesion is an anterior deviation. **Extreme flexion of the head and neck is productive of pain at the articulations of the second thoracic, if it is displaced.** The other indications of a lesion are the usual pain, tenderness, softening and thickening of the ligaments and irregularity, or at least some change of contour.

Lesions of this vertebra, and by lesion I mean a subluxation, affect the ligaments attached to it, the muscles in relation, and the contour of that part of the spine. These are affected in a way similar to that resulting from a lesion of the first thoracic vertebra, which has been described. The intervertebral foramina are lessened in size thereby compressing a part or all of the structures passing through them.

The **veins** are the lateral spinal which drain the spinal cord, the second thoracic segment in particular. They empty on the right side into the right superior intercostal, which empties into the vena azygos major; on the left they empty into the left superior intercostal vein which empties into the innominate. A lesion of the second thoracic vertebra or corresponding ribs will cause pressure on these veins, hence passive congestion of the parts drained by them.

The **arteries** come from the superior intercostal. The spinal branch as stated above, divides into branches which supply the vertebra and the spinal cord with its coverings. Vascular changes in the cord would

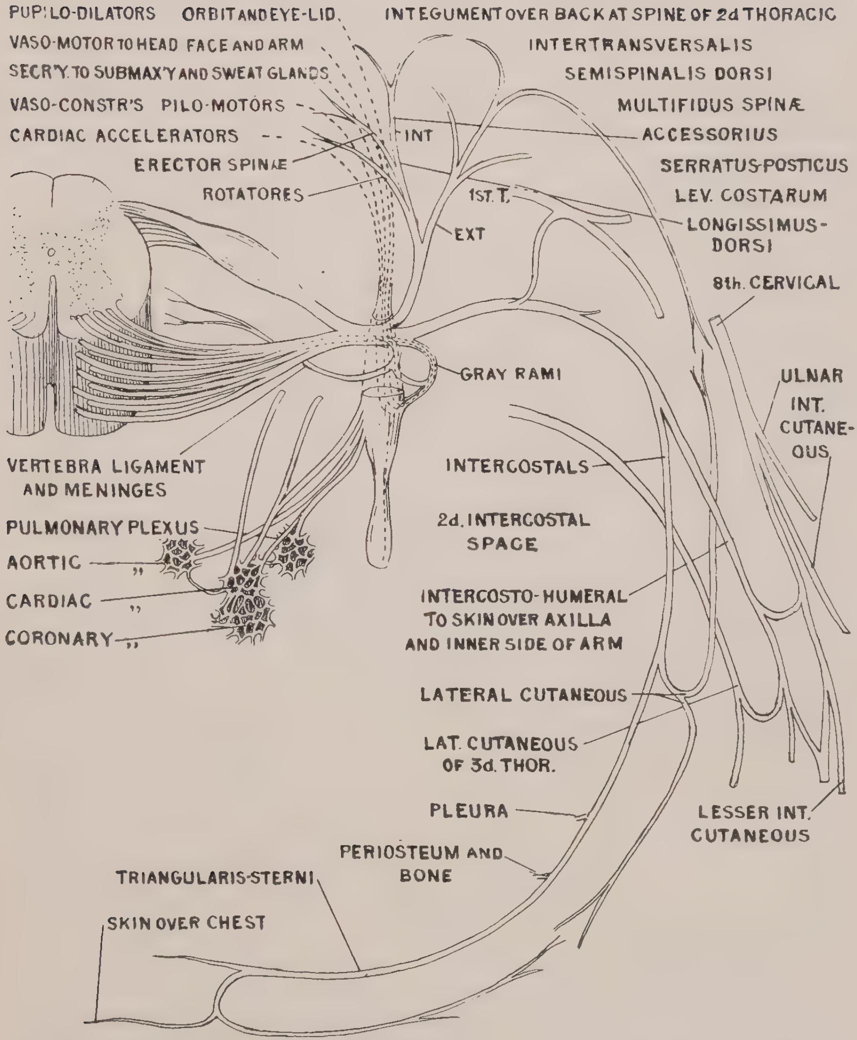

FIG. 36.—The second thoracic segment of the spinal cord, with its nerves and their distribution.

follow change in size of the intervertebral foramen, and muscular disturbances in that region.

The anterior and posterior **nerve roots** unite at the inner edge of the foramen, while the trunk thus formed divides at the outer part, into the usual anterior and posterior divisions. This nerve trunk formed by the uniting of the two roots, carries many and varied impulses which will be considered separately. They are motor, sensory, vaso-motor, secretory and trophic. The size of the foramen through which these nerve filaments pass, is determined by the position of the vertebra. In flexion of the body, the foramina are **increased in size** while **extension lessens their size. An anterior lesion** that is a subluxation, **has a greater effect on the size of the intervertebral foramen than does a posterior.** These lesions by thus affecting, that is, lessening the foramina, interfere with the passing of nerve impulses through, and over the nerve involved, and the effect varies with the degree of pressure and the nerves involved.

A motor effect is fairly constant in all lesions of the second thoracic vertebra. The muscles most frequently affected are the **erector spinæ, multifidus spinæ, intercostal, levatores costarum** and **serratus posticus superior,** the common effect being a relaxation or contracture. If the lesion is inhibitive, it will produce descent of the ribs, weakness of the spine, and a flattening or lessening of the normal posterior condition of this part of the spinal column. There are other causes of such effects since chronic disease of the heart and lungs will cause atrophy of these muscles and an increase in the width of the interscapular space. This is particularly true of tuberculosis of the lungs.

Contracture of the above named muscles, and this is the result of an irritative lesion, would displace upward the vertebral end of the upper ribs, extend or laterally flex the spine, approximate the vertebræ if the contracture is bilateral, thereby thinning the intervertebral discs and lessening the lumina of the intervertebral foramina. Movements of this part are painful and the muscles are tender on pressure. The circulation through them is altered and the spinal cord fails to be properly supplied with blood, hence disturbance of function of the various centers located in this part of it. The **dorsal** branch of the intercostal artery divides into a **lateral spinal** and a **muscular** branch, or rather a spinal branch is given off and the main trunk of the artery passes out to the muscles. By noting the relation of these branches it can be readily seen that a **contractured condition of the muscles supplied by the muscular branches would**

produce increased pressure in, and congestion of, the proximal branch, the spinal. The contractured muscle is congested and offers an obstruction ot the transmission of arterial blood. Thus the spinal cord suffers.

The **sensory effect** resulting from pressure on the spinal nerve, would be anesthesia or pain or some perversion of sensation as in **formication.** These disturbances would be marked in the second intercostal space, between the scapulæ and along the inner side of the arm. The last named part is affected because of the connection of the second thoracic nerve with the nerve of Wrisberg, by way of the intercosto-humeral. Disturbed sensation in the above mentioned places is due to some disturbance of the second thoracic nerve, this most frequently being the result of a lesion of the second thoracic vertebra or the corresponding rib. These sensory disturbances are explained in several ways. In some cases they are the result of direct pressure on the nerve trunk. This produces numbness, or a tingling sensation, and possibly a distinct pain in exceptional cases. The lesion may interfere with the blood supply of the nerve trunk and in this way, that is, by producing a congestion, interfere with its function. The subluxated vertebra may obstruct the circulation to the second dorsal segment of the spinal cord in which are located the cells that control the efferent impulses. Again, this lesion by causing contracture of the muscles of the spine, causes sensory disturbances. This effect is characterized by an ache or else the part becomes easily fatigued on exertion. The sharp, **lancinating pain** is due to irritation of the nerve; the **ache,** to contractured muscles; the **numbness,** to pressure on the nerve trunk. These effects are in the main due to the direct result of the lesion, but in some cases, they are due to heart and lung disorders in which cases they are reflex.

The second intercostal nerve also supplies the pleura, the rib and its periosteum. In the female it supplies the mammary gland. Thus there may be pleurisy, caries of the rib and mammary affections.

The **white rami** join the anterior division of the nerve with the corresponding ganglion on the sympathetic cord. The fibers come from the spinal cord, hence pass through, and form a part of, the cerebro-spinal nerve as it lies in the intervertebral foramen. A lesion of the second thoracic, by lessening the size of the foramen, would produce pressure on at least some of these fibers, hence some disturbance of the parts supplied by the impulses traveling over these fibers. These fibers convey **vaso-motor** impulses to the head and face, hence eruptions on the

face, headaches and any vascular disturbance of these parts may follow a lesion affecting these fibers contained in this nerve trunk. **Pupillo-dilator** fibers also pass out through the second nerve and reach their destination by way of the cervical sympathetic nerves and their branches as described in the discussion of the first dorsal vertebra. The **involuntary** muscles of the eyelids and orbit have a center in the second thoracic segment of the spinal cord, the impulses from which, reach their destination by way of the white ramus and the cervical sympathetic and the Gasserian ganglion. The **submaxillary** gland receives its secretory impulses from this segment, they reaching it in a way similar to those above described. A lesion of the second thoracic vertebra would affect the passing of these impulses hence an altered secretion of the saliva. The writer has treated cases of dryness of the mouth resulting from a lesion of the second thoracic. The opposite condition may result.

Some of the **sweat** centers controlling the secretion of sweat in the arm are located in this segment. The impulses reach the arm by way of the roots and trunk of the second thoracic nerve, white ramus, gangliated cord and brachial plexus or subclavian plexus.

The **vaso-motor** centers for the arm are also located in this segment and reach their destination in a similar way. Therefore, excessive or lessened perspiration of the arm, congestion or coldness of the arm, in fact any vascular change in it may follow a lesion of the second thoracic.

The vaso-motor centers for the retinal vessels and the blood-vessels of the ear are located in this segment, the impulses from which pass out over the white ramus to the gangliated cord thence to their destinations. "Stimulation of the cervical sympathetic nerves produces contraction of the retinal vessels. Stimulation of the upper thoracic sympathetic nerves produces dilatation."

The **vaso-constrictor** nerves to the **pulmonary vessels** pass in part through the second thoracic foramen. The size of the pulmonary vessels is controlled by these nerves. If these nerves are inhibited the pulmonary vessels dilate. As a result the circulation of the blood through the lung for æration is lessened, the blood is not properly oxygenated and the entire body suffers. The patient is tired because of impure blood. **Fatigue is due to impure blood.** The better the circulation through the lung the better the blood is oxygenated and the more rapid the recovery from fatigue. Again, the lung and body are predisposed to disease when the pulmonary or bronchial vessels are dilated because (1) of the con-

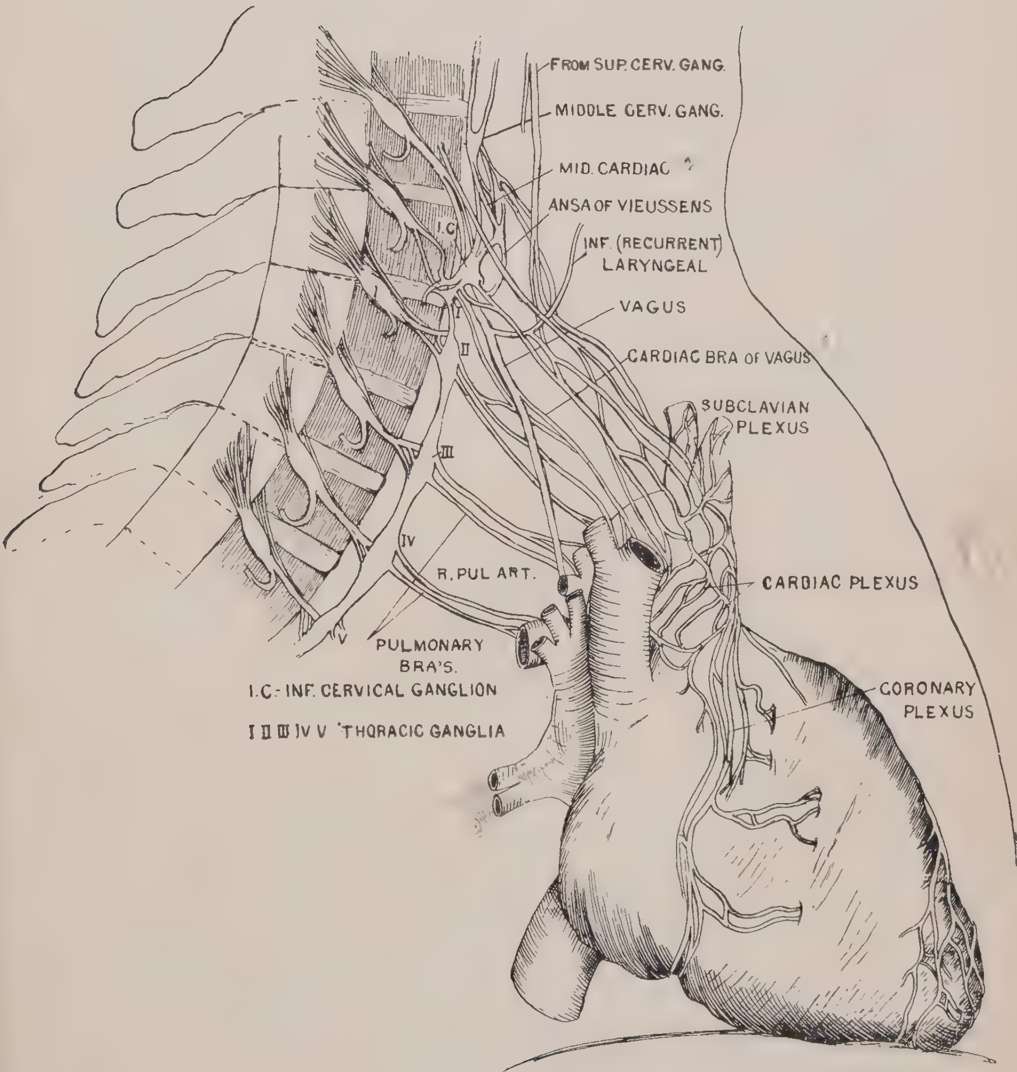

Fig. 37.—Showing the innervation of the heart.

gestion of the lung and (2), because of the interference with oxygenation of the blood and nutrition of the lung substance. Germs or toxic material inhaled, are not readily destroyed.

The centers which give rise to **accelerator impulses** to the heart are also located, in part, in this segment. These impulses pass over the anterior nerve root into the mixed nerve, out over the white ramus to the second dorsal sympathetic ganglion, then either up the cord to the stellate ganglion thence over the cervical cardiac branches, or else directly across to the cardiac plexus, as McClellan states. In several dissections the author has found quite a **large branch connecting the vagus** with one or more of the **upper thoracic sympathetic ganglia.** The impulses pass over the different filaments in the nerves in the foramen. This nerve is subject to pressure from lesions, hence the heart trouble. Not only is the cardiac plexus affected but the **coronary plexus** as well. This plexus controls the nutrition of the heart.

The **bronchi** will be involved because of the disturbance of their nerve supply. This comes principally from the pulmonary plexus. This plexus is formed by nerves from the upper thoracic segments. They pass out of the spinal canal through the intervertebral foramina. A lesion of the second dorsal will affect the passing of the impulses over these filaments. Congestion of the respiratory tubes may follow. Nature tries to expel the foreign body by coughing. The foreign body is most frequently a thickened mucous membrane or exudate.

The vaso-motor innervation of the nasal tract comes from, at least in part, the second thoracic segment. On this account, a lesion at this point will affect the vascular supply of this part, hence any disease in which the circulation is involved. Clinically, the lesion producing hay fever, especially complicating asthma, is found at the second thoracic vertebra. The explanation is that the subluxation intercepts the passing of the vaso-motor impulses, hence the congestion and hyper-secretion of the nasal mucous membrane. These impulses pass through the second thoracic intervertebral foramen and it is at this point that the disturbance takes place.

The splanchnic nerve may arise as high as the second dorsal segment but this is to be doubted. In such cases the impulses pass out over the cerebro-spinal nerve and the white ramus, thence down the gangliated cord to the fifth dorsal ganglion, from which they pass over the ramus efferens. From this it theoretically follows that a lesion of

the second dorsal will produce disorders in viscera supplied by this portion of the splanchnic, if the transmission of the impulses is interfered with by the lesion. Clinically it is unusual for a lesion so high to affect the viscera supplied by the great splanchnic.

The impulses passing over the grey ramus enter the corresponding cerebro-spinal nerve, thence to parts supplied by this nerve. As stated above, the nerve fibers are, in all probability, medullated, and connect the viscera with the spinal cord, they passing through without interruption to the posterior nerve roots. In this way the heart and lungs are supplied with sensation by the upper thoracic branches of the spinal cord. The pain is usually referred to the intercostal nerves when these viscera are involved. Note the "grip-like" pain over the heart in angina pectoris and the stabbing pain of pneumonia. The pain in these cases being in the intercostal, that is cerebro-spinal nerves.

The fibers that pass distally in the somatic nerves "supply vasomotor nerves to the arteries of the body-wall and limbs, pilo-motor fibers to the muscles of the hairs and secretory fibers to the sweat glands." Every nerve fiber passing through the second thoracic foramen is subject to pressure or other disturbance, from a lesion of the second dorsal. All of these may be involved, or only a few may be affected; in every case some of these fibers are disturbed. Disorder of the parts supplied necessarily follows, hence the above named affections.

This lesion will affect the gangliated cord since it is in relation. Although the main function of this cord seems to be that of demedullating fibers and transmitting impulses, yet some impulses arise in the ganglia. A lesion of the vertebræ will thus produce disease by affecting these ganglia, by interfering with their blood supply, rather than by direct pressure on them.

The various **centers** located in this segment of the cord are subject to impairment through a derangement of the circulation to the segment. Again a diseased or simply a weakened condition of the viscera supplied by the segment will reflexly affect the centers in it. A lesion of the second dorsal vertebra will weaken the lungs and heart, thus the segment will reflexly be affected. An error in diet will cause congestion of the spinal cord and contracture of the muscles of the back. Excessive coitus will congest the spinal cord, usually the lower thoracic segments. Cold on the lungs will affect the second dorsal segment and produce contracture of muscles in relation. In this segment are located the various

centers named above, such as **vaso-motor** to head, face, arm, lung and heart; **motor** to the muscles in relation, heart and eye; **sensory**, which are really in the ganglion on the posterior nerve root, to the heart, lungs, pleura and the integument over the second intercostal space and a portion of the interscapular region; **secretory** to sweat glands of arm, and to the submaxillary glands; **trophic** to the arm, rib, periosteum, ligaments and vertebra. Each of these centers may be involved, or only one may be affected. From this can be ascertained the variety of structures that may become diseased from this lesion, also the kind of disease. Lesions of the second dorsal are clinically most commonly looked for in diseases of the head, such as congestion, and vertigo; and in arm and lung diseases.

THE THIRD THORACIC.

The **third thoracic vertebra** differs slightly from the second in that its spine is slightly longer and more beaked or knobbed than the spine of the second. The transverse processes point upward and outward for articulation with the rib. This the better supports the ribs. The facets on the transverse processes in many skeletons examined by the author, face slightly upward, this also helping to support the ribs. The superior articular facets face backward, slightly outward and upward and their surfaces are plane. The mobility of the articulations varies little from those of the second. The lesions are also similar, that is any form of deviation may take place, a lateral rotation being most common. As a result of a lesion of it the muscles and ligaments attached to it, are always involved. The foramina are lessened and some or all the structures passing through are involved.

The **veins** and **arteries** are analogous to those of the second.

The **nerves** passing through the foramen between the third and fourth thoracic vertebræ, carry motor impulses to the heart, possibly the lungs, pupil, and muscles in relation. The impulses to the heart travel by way of the anterior root, common nerve, white ramus, ganglion and rami efferentes. Those to the pupil pass up the gangliated cord and out over the fifth cranial.

Although it has not been demonstrated that motor impulses pass from the upper part of the thoracic spinal cord to the bronchi and bronchioles, yet, judging from the effects of treatments applied in this region in patients suffering with motor disorders of these parts, one is almost

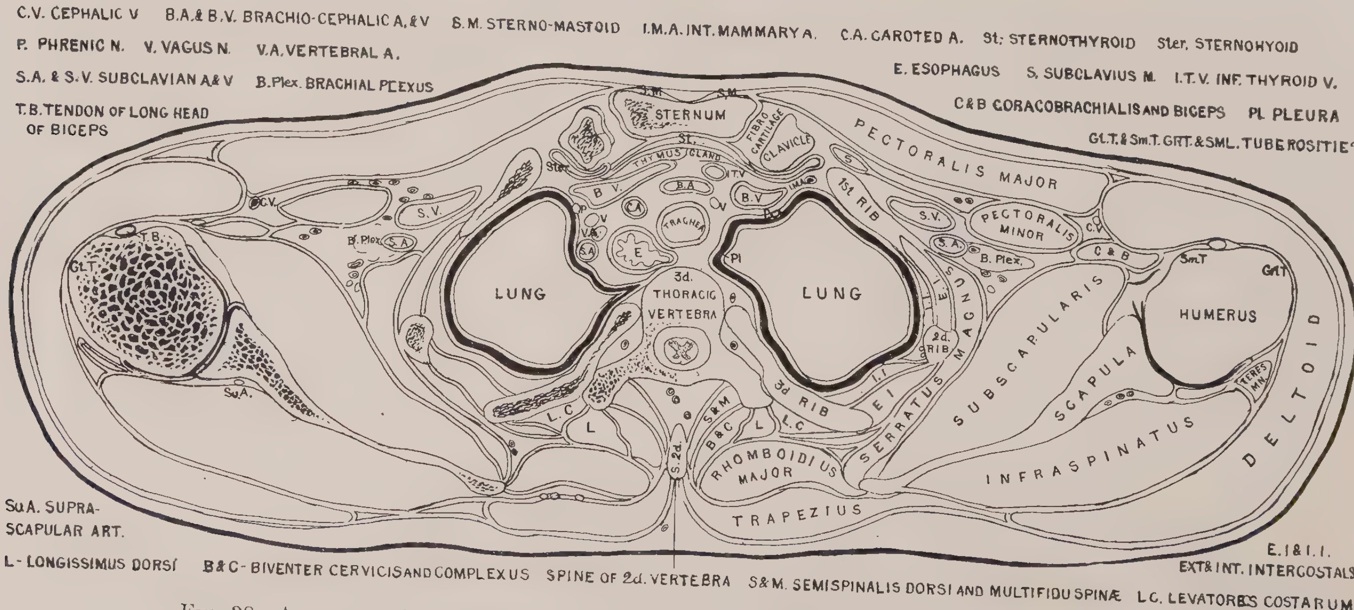

Fig. 38—A cross section of the body at the level of the body of the third thoracic vertebra.

forced to the conclusion that they do. In the paroxysm of asthma, the attack can either be entirely stopped or at least lessened in severity by treatment applied to this area. Sometimes pressure alone will relieve. Although it is possible to explain these effects in a way, by means of the vaso-motor connection, yet we do not believe this the true explanation. Experimentally, stimulation of the anterior roots of these nerves in animals has no noticeable effect on the size of the bronchi, but clinically in man, the correction of a rib lesion in the upper thoracic region will almost instantly relieve an attack of asthma unless the case is a very chronic or severe one.

The **muscles** supplied are the intercostals, levatores costarum, serratus posticus superior, multifidus spinæ and erector spinæ. These muscles will be either relaxed or contractured by a lesion affecting their nerves.

Sensory impulses from the integument of the axilla and arm, third intercostal space and upper part of back pass through this foramen. Sensation of the heart and lungs is controlled by nerve filaments that pass through this segment, the impulses therefore passing through this foramen. The impulses from the integument pass up the anterior and posterior divisions of the nerve, thence over the posterior root into the spinal cord, usually directly across to the opposite side. The sensory impulses from the heart and lungs are probably carried by special nerves that pass through the sympathetic ganglia with little or no alteration, as Quain points out. Some pass through the white rami, the third posterior root and finally into the spinal cord. On account of these sensory connections, a disease of the heart or lung will give rise to impulses that travel into the spinal cord, and the sensorium refers them to the areas of distribution of the upper thoracic nerves, principally the intercostals. To illustrate, the pain in heart disease is described by the patient as in the precordial region. It is referred to this point.

The **pleura** is supplied with sensation by the third intercostal, hence pleurisy often follows a lesion of the third thoracic vertebra. The impulses pass over the intercostal to the spinal cord thence to the sensorium. False pleurisy results from some forms of vertebral lesions. The pressure is exerted on the nerve while in the foramen, the impulses thus generated pass to the sensorium over the usual route but are referred to the periphery of the nerve, hence the "stitch" in the side from a rib or vertebral lesion.

In the female, the **mammæ** are supplied by the third intercostal nerve. This nerve is principally sensory hence in painful conditions of the breast the intercostal nerves are involved.

Again, lesions, such as that of the third dorsal, cause painful conditions to be referred to the breast. In all cases of pain in the mammary region ascertain if there is a local, organic disturbance, or if it is purely reflex. The vertebral or rib lesion is responsible, in either case, for a vast majority of diseases of the breast.

Vaso-motor impulses to the arm, head and face, lungs, heart, muscles of back, spinal cord and its coverings pass in part through this foramen. The different pathways are described above under the second dorsal.

The arteries involved by this lesion are those in relation and those innervated by the vaso-motor nerves that pass through the foramina in relation with the third dorsal vertebra. The **intercostal** arteries are supplied with vaso-motor impulses derived from the third thoracic segment. These pass by way of the thoracic aortic plexus. On this account the lesion will affect this artery, either causing its constriction or dilatation. This artery supplies the part of the chest wall in relation, the pleura, the rib and its periosteum, the muscles of the back and the spinal cord. As a result of the lesion there are vaso-motor effects in these parts. The **lateral spinal** arteries which are branches of the intercostal, are in relation with the vertebra and would be affected partly on this account, and, partly on account of the relation of their vaso-motor nerves to the third thoracic vertebra. This artery supplies the spinal cord and its coverings, hence vascular disturbances of the part when the vessel is increased or decreased in size.

The **carotid** arteries are affected since they receive their vaso-motor impulses from the thoracic area. Some of these impulses pass out through the foramina in relation with the third thoracic vertebra. As a result of such a disturbance, the amount of blood in the parts supplied by these arteries and their branches becomes pathologically changed. Usually the artery is dilated and congestion of the parts is the sequel.

The **vertebral** artery receives its nerve supply from this part of the spinal cord and thus would be affected by lesions of the second and third. Its function and distribution have been considered before.

The **pulmonary** vessels receive their vaso-motor impulses partly by way of the nerve passing through the third intervertebral foramen. Consequently, there will be congestion or anemia of the lungs. This predisposes to pneumonia.

The **bronchial** vessels also receive their innervation in a similar way. An upper thoracic lesion will thus affect the **nutrition** of the lung, this predisposing to diseases of the lung tissue, such as tuberculosis.

The **coronary** arteries which control the nutrition of the heart's muscle, receive their vaso-motor impulses from the upper thoracic spinal cord. They pass out over the anterior nerve roots, the common trunk, the anterior divisiòn and thence by the white ramus into the gangliated cord and cardiac plexus. As a result of a lesion at the third thoracic vertebra, the nutrition of the heart may be interferred with. **Angina pectoris** is perhaps the best example of this form of disease.

The **axillary** artery and its branches are also innervated in part from this segment, thus diseases of the arm often result from lesions as low as the third thoracic vertebra.

A lesion of the third dorsal will interfere with the passing of these impulses and the blood-vessels of the above named parts are affected. The usual effect on the vessel is that of dilatation. The effect of a lesion pressing equally on all the fibers composing the nerve trunk is manifest first in the weakest part. Although each may be affected, the strongest resist longest and the weakest are affected first. A lesion of the articulations of the third dorsal vertebra, may, in one case, produce a vaso-motor effect in the eyelids, in another case, in the throat. The explanation is, the weakest part is affected most if a lesion disturbs all of these fibers alike, but ordinarily the lesion affects some fibers more than others. A lesion of the third thoracic vertebra produces vaso-motor disturbances in the above mentioned structures by producing pressure on the nerve fibers as they pass through the foramen, by producing pressure on the blood-vessels supplying or draining the spinal cord, or by pressure on the gangliated cord or rami which are in close relation.

The **sweat** glands of the arm and back (upper part) and the submaxillary glands receive impulses which are carried by nerve fibers passing through the third thoracic intervertebral foramen. The effect on these glands is variable; sometimes there is increased activity, sometimes lessened activity.

If there is a dry condition of the skin, or if there are night sweats, the lesion is found most frequently to be in this region, the articulations of the third thoracic being most commonly affected. Perhaps these effects are the result of the direct disturbance of the sweat glands or perhaps the result of general nutritive disturbancės. The latter seems to

be the better explanation since in practically all such cases, there is malnutrition. If the sweat disorders are not accompanied by nutritive changes, the sweat glands are directly affected, but this is the exception rather than the rule.

Trophic fibers are derived from the third dorsal segment that supply the arm, periosteum of the third rib, the third rib itself and all other parts supplied by the third thoracic nerve. A general **nutrition center** is supposed to be located here which will be considered later. The writer has seen cases of **caries** of the ribs result from a spinal lesion.

Atrophy of the arm is not unusual by any means, as a sequel to a lesion of the third dorsal vertebra. Several cases have come under my notice in which the arm was completely paralyzed, both sensory and motor, as a result of a hard lift or injury by which the third thoracic vertebra was dislocated, or rather subluxated, thus producing a monoplegia. In many of such cases there is a dislocation of the acromial end of the clavicle.

The **third thoracic nerve** connects with the third dorsal sympathetic ganglion and occasionally sends a filament to the nerve of Wrisberg and other filaments which communicate peripherally with the supra-clavicular branches of the cervical plexus. Through the third ganglion communication is established with the second and fourth sympathetic thoracic ganglia, pulmonary, cardiac, coronary and solar plexuses, and in some cases the pneumogastric. The author has made and seen dissections in which was found quite a large branch directly connecting the third and fourth sympathetic ganglia with the vagus.

The function of this connecting branch can only be surmised. It, in all probability, carries impulses from the **spinal cord to the thoracic viscera** or perhaps to other viscera and structures supplied by the pneumogastric nerve. If the branch were constant, the various effects of an upper dorsal lesion on the lungs and heart, could the more easily be explained, especially asthma and motor disorders of the heart. So far as I know, no experiments have been performed by which the function of this connecting branch could be definitely ascertained since it is not recognized as a constant branch.

In marked dislocations of the third thoracic, as in other vertebræ, **transverse myelitis** may develop, from pressure on the cord exerted by the displaced vertebra. At the third thoracic vertebra, paralysis, both motor and sensory, of all parts below would follow. The line of demarkation can be definitely outlined, it following the intercostal nerve.

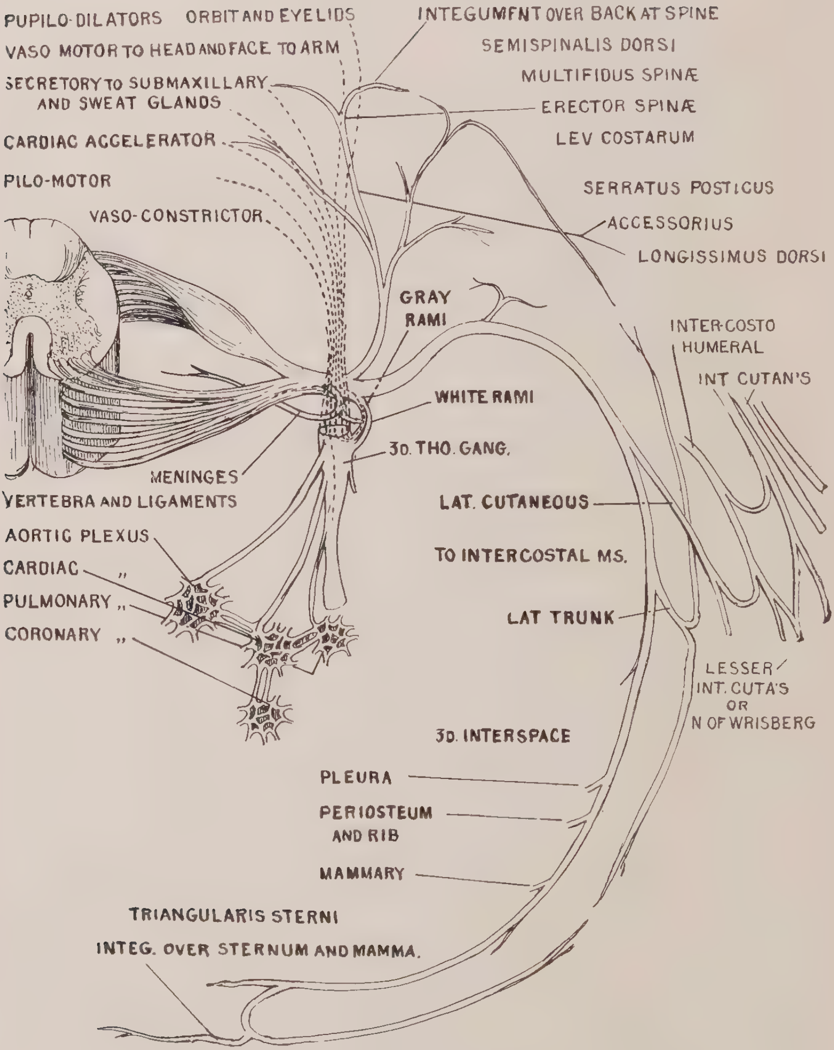

Fig. 39.—Showing the third thoracic segment with its nerves and their distribution.

The **spinal cord** is affected in ways other than by pressure directly on it. Pressure on the posterior nerve root or ganglion will cause ascending degeneration thus involving some or all the sensory columns of the spinal cord. **Locomotor ataxia** probably has its origin in pressure or other disturbance of these posterior nerve roots. Pressure of the dislocated vertebra on the blood-vessels affects the drainage, also the nutrition, hence activity of the cord and its centers.

Clinically, there seems to be various **centers** in the spinal cord which are affected by a lesion of the articulation of the third and fourth thoracic vertebra. The author has had patients complain of a weight resting, as it were, on their back and shoulders and in nearly all such cases some disturbance of the third or fourth thoracic vertebra, was found, upon the correction of which, the symptoms were relieved. Others are hysterical and want to cry; some have hysterical fits of laughter. On account of the effects of a subluxation of the third on the emotions it has been given as an **emotional** center. Why it exerts such an influence on the emotions no anatomical explanation will be attempted, only these clinical phenomena above mentioned.

Subluxations of the third and fourth thoracic vertebræ, seem to produce **malnutrition of the entire body,** and from the frequency of disordered nutrition following such lesions, it is reasoned that there is a center at or near this region, which controls the nutrition of the body. This center is in all probability, in the grey matter of the third and fourth segments of the thoracic spinal cord. The explanation that I would offer is the fact that these segments have to do with supplying the **vital** organs of the body, viz., the **heart, lungs** and **stomach.** Thus a lesion affecting these segments would interfere (1) with the **circulation of the blood,** the heart being weakened, (2) with the **oxygenation of the blood** and (3) the **process of absorption** or power to take nourishment from the ingested food. **Circulation** of the **blood** is **necessary** to **nutrition, oxgenation** of the tissues is indispensable, thus the general result, **malnutrition.** The kind of lesion found, is a flattening of this area of the spine.

The **cilio-spinal** center is located, in part at least, in this segment. Headache from eye disturbances can ofttimes be cured by correcting a lesion of the second or third thoracic vertebral articulations which affects the cilio-spinal center. This center is either irritated or inhibited by the lesion. There is a vascular effect in the eye, the parts most frequently becoming congested and headache follows. As stated above,

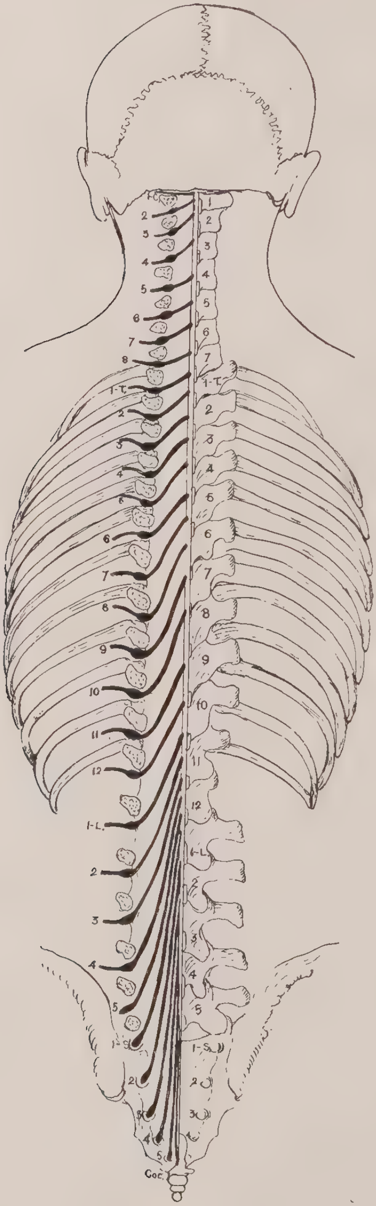

FIG. 40.—Diagrammatic representation of the roots and ganglia of the spinal nerves, showing their position in relation to spinal column (after Cunningham). The ganglia are in the intervertebral foramina and are subject to pressure in subluxations of the vertebrae on account of change in size of these foramina.

the impulses pass out from this center over the anterior root into the common trunk, white ramus, gangliated cord, thence up and out over the third and fifth cranial nerves.

The **center for the accelerator** impulses of the **heart** is located in part, in this segment. Palpitation, arrhythmia and other effects are manifest when this center is disturbed.

The center for the **lungs** is also located in part, in this segment of the spinal cord. A lesion of the articulations of the third dorsal will weaken the lungs. **Repeated contractures** of the muscles of the upper part of the back will also weaken the lungs thus predisposing the patient to tuberculosis of the lungs. Repeated colds on the chest is an example. Congestion of the lung will produce contracture of the muscles supplied by this segment, also pain in the areas supplied with sensation by the nerves of this segment. The sharp intercostal pain in pneumonia, and the tenderness of the intercostal muscles in pulmonary tuberculosis, are examples. The well known and much used counter-irritant, is another illustration of how a stimulation of one part causes an effect in another, through the spinal cord. The explanation is that the spinal center, located in part in the third thoracic segment, controls the lung and the sensory and motor nerves supplying the part of the chest wall in relation, and the irritation of the peripheral nerve, will cause an effect in this segment, hence in branches coming from the segment.

The **arm** has a special **nutritional center** in these upper spinal segments, as is evidenced by cases in which there is monoplegia resulting from lesions of the articulations of the third thoracic vertebra. Perhaps the vaso-motor centers and nerves have a great deal to do with the nourishment of the arm, these centers being in this segment. If the trophic center and nerves are separate from, and independent of the vaso-motor nerves, we can offer no explanation as to the pathway of these impulses which are supposed to pass from this segment to the arm. Clinically, it is well known that a lesion of the upper thoracic vertebral articulations, is often followed by an atrophic change in one or both arms.

Sweat centers are also located here which control the amount of perspiration of the upper part of the spine and arms. Localized sweating of a lateral half of the face most commonly results from a neck lesion, but may come from lesions lower in the spinal column. Localized sweating along the median furrow comes from a lesion of an upper thoracic

vertebra. Sweating along the course of a rib is suggestive of a rib lesion (the one in relation). This produces a lowering of the temperature of the part. Abnormal dryness of the skn of the upper part of the back and chest may follow a lesion of the third thoracic vertebra, which in turn, disturbs the normal activity of the sweat centers for these areas.

Some forms of **chorea** result from lesions in this part of the spinal column, judging from clinical observations. In some of the cases treated by the writer, in which the arms were especially affected, the lesion was found to be in the upper thoracic area and upon its correction the choreic symptoms disappeared. I have no explanation to offer for this unusual effect of the lesion unless it would be possible for the subluxation so to interfere with the passing of motor and vaso-motor impulses to the arm that they pass intermittently instead of constantly. The obstruction to the passing of impulses over the nerve to the arm produces a damming up of the impulses which after a time, when the pressure gets to be quite strong, break over and thus the spasm or rather the uncontrollable contraction of the muscles supplied. Clinically, pressure applied near, or at the exit of the nerve from the spinal column, will lessen or completely stop the choreic spasm. From this we conclude that the trouble is at the exit of the nerve, that is in the foramen.

Summary. A lesion of the third thoracic vertebra may produce disease of the bronchi, lungs, heart, stomach, arm, vertebral column, spinal cord, upper part of chest and back, neck, pleura, mammary glands, and structures in the cranial cavity, especially the eye, salivary glands, ear and nose. The most common diseases following a lesion of this vertebra are pneumonia; pulmonary tuberculosis, the lesion in these diseases so weakening the lungs that the different pathogenic micro-organisms gaining access to the lung set up pathologic processes; arrhythmia, palpitation, angina pectoris, chronic cough (dry or hacking); disturbances of vision; mammary diseases; pleurisy; paralysis of arm; chorea; writer's cramp; pain between shoulders; stiffness of neck and headache.

THE FOURTH THORACIC.

The **fourth thoracic vertebra** is one of marked importance on account of frequency of subluxation and the profound effects from lesions of it. It is located in a rather weak part of the spinal column, is subject to great strain when the arms and shoulders are used as in strong muscular exertion, and is the seat of trauma of different kinds, especially

that resulting from a sudden push or blow between the shoulders as in the case of school children, one suddenly and forcibly pushing another at an unexpected moment. This produces an anterior condition and often is the starting place of **Pott's disease** of the spine and spinal curvature.

The fourth, seems to be the point of division between the upper and lower parts of the spinal column. Dr. Still has often told me that in disorders of parts above, that is of the head and face, look as low in the spine for the lesion as the fourth, while in affections of parts below, look as high as the fourth. The explanation of this is that the heart is at this level, that is all parts above the fourth are supplied with blood by the ascending branches, while all parts below this vertebra, are supplied by the descending branches. This is true in the main. In a general way, expect the lesion to be between the part affected and the heart.

The **superior facets** of the vertebræ in this region are so placed that a directly anterior displacement without separation, is practically impossible, but they may rotate in various directions. The **anterior rotation** causes an **approximation** of the **spines** of the third and fourth vertebræ and a **separation** of the spines of the fourth and fifth dorsal. The break is below the lesion, and is a point of increased mobility. At the point of approximation of the spinous processes, mobility is lessened and is the place that most needs treatment. The object in the treatment of such a condition, as in all vertebral subluxations, is the **restoration of normal mobility.** **Lateral rotation** of a single vertebra, results in a lessening of the size of the intervertebral foramen **on the side to which the vertebra is turned.** The opposite intervertebral foramen is either not affected or is increased in size. In such cases there is a unilateral effect as in monoplegia, an upper extremity being involved. Usually in such a lesion, there is a palpable irregularity although this does not hold true in every instance. The author has seen dissections in which no bony lesion could be palpated by external examination, so far as contour was concerned the spines being very regular, but on dissecting the articular processes, quite an irregularity or subluxation was found.

These lesions of the fourth dorsal, affect structures attached to it, blood-vessels and nerves in relation, and centers and viscera depending for their activity upon normal position of the bone; an abnormal position interfering with their nutrition and motor, vaso-motor or sensory supply.

The principal **muscular effect** of a lesion of the fourth thoracic vertebra, is manifest in the erector spinæ muscle. At first it becomes contractured but after a while, atrophies or becomes degenerated and hardened. The median furrow, which is formed principally by the two erector spinæ muscles, is widened in chronic cases, at the point of lesion and especially so, if several adjacent vertebræ are involved. The other muscles involved by this lesion are the levatores costarum, rotatores spinæ, multifidus spinæ, intercostals and serratus posticus superior. As a result of these muscular disturbances flexion, extension and rotation of this part of the spine are painful and difficult or weakened. The rib movements are impaired or in some cases, the ribs are subluxated by the continued contracture. In other cases relaxation, instead of contracture, follows the lesion. This permits of descent of the ribs and causes the spine to be imperfectly supported. The patient drops the shoulders and sits with the spine very much arched posteriorly, that is the patient is "piled up" instead of sitting erect and supporting the weight of the trunk on the tuber ischii.

The **blood-vessels** affected are the veins and arteries passing through the fourth thoracic foramen, those of the muscles in relation and some or all of the branches of these vessels.

In addition to these, the thoracic aorta in relation, with its branches will be affected. The branches involved are, the **pericardiac, bronchial, esophageal,** and the **fourth intercostal.** These arteries are innervated by branches of the thoracic aortic plexus, which is derived from the nervi efferentes of the upper thoracic sympathetic ganglia. On this account, a lesion of the fourth dorsal vertebra will disturb the function of this plexus and thus affect the amount of blood passing to the above named parts. The effect on the vessels is one of obstruction, or vasomotor inhibition, therefore congestion occurs in most instances; however, anemia may result.

The parts congested are the spinal muscles, pleura, spinal cord; in fact all structures in relation are subject to congestion by this lesion. The spinal vessels are supplied with nerves by the recurrent nerve and by filaments from the thoracic aortic plexus, which gives rise to fibers that accompany the intercostal arteries and their branches.

The following **nerves** are affected, most of them directly, by a lesion of the fourth thoracic vertebra: **Fourth thoracic** with its intercostal or anterior, and posterior divisions, muscular branches of the above,

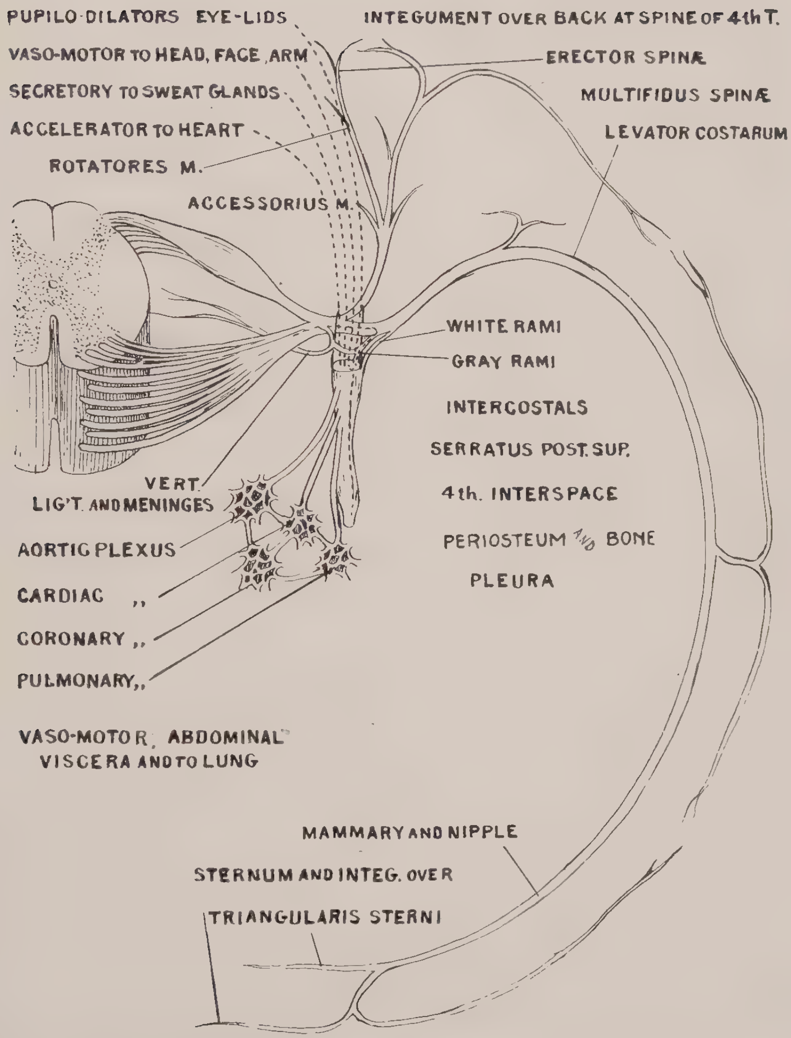

Fig. 41—Showing the fourth thoracic segment with its nerves and their distribution.

recurrent meningeal, grey and white rami, the fourth thoracic sympathetic ganglion and its branches and the gangliated cord.

As a result of an impairment of the fourth intercostal nerve, the intercostal muscles, pleura, mamma, fourth rib and its periosteum are disturbed in some way as to function. The intercostal muscles are most frequently relaxed, thus respiration is impaired. If the lesion is an irritative one, the muscles become tender and contractured to a slight degree, at least they become swollen. The pleura is affected, there being pain on inspiration or what is more frequently described as a "catch" or "stitch" in the side.

These painful affections follow such a lesion because (1) the parietal layer of the pleura receives its sensory innervation from the intercostal nerve in relation, the nerve being affected by the lesion, and (2) because the pleural surfaces move on each other in respiration. These surfaces are swollen, sometimes inflamed, and the least movement is productive of excruciating pain.

The **mammary gland** is involved by this lesion. The character of the disturbance may vary between a slight pain and a cancerous condition. This nerve, i. e., the **fourth intercostal,** seems to be sensory, trophic and possibly secretory to the gland. The effect of the disturbance of the nerve may be pain, lack of development or atrophy and lessened secretion of milk.

It has not been definitely demonstrated that the mammary gland has any secretory nerves at all. Clinically, it would appear that secretory nerves supplied the gland and that they came by way of the intercostals in relation. This is based on observations of the results of rib lesions and the effects of their correction. As in other glands, the secretion depends to a large degree on the blood-supply.

Howell says, in discussing the mammary gland: *"Regarding the question of the existence of a secretory nerve, Basch reports that the extirpation of the celiac ganglion or section of the spermatic nerve does not prevent the secretion, but causes the appearance of colostrum corpuscles. Experiments, therefore, as far as they have been carried, indicate that the gland is under the regulating control of the central nervous system, either through secretory or vaso-motor fibers, but that it is essentially an automatic organ."

*Text-book of Physiology, page 857, 1905.

The **trophic** effects may often result in ulceration, which simulates cancer, and in tumefactions of the breast.

The **fourth** rib is also supplied with trophic impulses by the fourth intercostal, hence often suffers as a result of lesions involving this nerve. The writer has seen cases of caries of the rib result from a vertebral lesion, the disease being diagnosed as tuberculosis of the rib. The periosteum of the rib is of course also supplied by this nerve, this probably explaining the caries in such cases in which this nerve filament is involved.

Sensation of the fourth interspaces is affected by a lesion involving the fourth dorsal vertebra. Pain is the most common effect, although numbness, burning sensation or some other form of perverted sensation may occur. Complete sensory paralysis is uncommon but is occasionally met with in cases of marked vertebral lesions.

The **posterior division** supplies a part of the integument over the middle part of the thoracic region and the muscles in relation, the internal branch supplying sensation, while the external branch is principally motor. This nerve is frequently involved in uterine or other pelvic disease. Aching between the shoulders is a very common symptom in these cases. I believe that in such cases the muscles of the upper thoracic region are reflexly put in a contractured state and, like other muscles, they soon become fatigued and begin to ache. The pathway of the reflex arc is not well understood. The author presumes that there is a center in the fourth thoracic segment that controls the activity of the mammary glands. These glands are parts of the generative system, hence closely connected in every way with the rest of the generative organs. On this account, they are subject to reflexes as a result of pelvic derangement. The muscles ache the more when used. If the patient should attempt to use the shoulders and arms as in sweeping, the shoulders ache for some time afterwards. This reflex ache **seldom occurs independently of a lesion of the vertebræ or ribs** in relation, the lesion acting as the predisposing cause. If this were not the case every woman suffering with a congested uterus would have a pain or ache between the shoulders.

The **grey ramus** is subject to pressure from a subluxation of the fourth dorsal vertebra. This pressure is most frequently indirect, that is through adjacent tissue which is deranged. Sensory and vaso-motor impulses are carried by this nerve, hence an affect on the spinal cord and

the part of the thoracic wall that is in relation, to which this nerve carries impulses.

The **white rami** are also subject to impairment in the above lesion. The fourth white ramus carries from the fourth dorsal segment to the fourth thoracic sympathetic ganglion, impulses for the eyes, head and face, heart, lungs, bronchi and arms; thus disease or weakening of any or all of these organs and structures may result from a lesion impairing this white ramus. It also carries afferent impulses from certain of the viscera, to the spinal cord.

The **gangliated cord** and the fourth thoracic sympathetic ganglion are sometimes affected directly by a lesion of the articulations of the fourth. This ganglion gives rise to the following branches: Filaments that pass to the thoracic aortic, cardiac, pulmonary and coronary plexuses and small branches to the vertebræ and their ligaments. Most of the impulses passing over these branches originate in the spinal cord, a few perhaps being formed in the sympathetic ganglia. In either case the effect of the lesion would practically be the same; that is, an interference with the transmission of the impulses to the lungs, heart, vessels and vertebræ.

The nerves connecting with the fourth dorsal nerve are the fourth thoracic ganglion and, through this ganglion, the third and fifth ganglia and the solar, pulmonary, cardiac and coronary plexuses.

The parts that are most frequently affected or actually diseased by this lesion are, the eyelids, optic nerve, retina, ocular muscles, the head, face, heart, lungs, arm, pleura, chest wall, mammæ, spine, back, spinal cord, everything in the fourth intervertebral foramen, the abdominal vessels and stomach. The eye and its appendages are not often affected by a lesion so low. In the dog it has been shown experimentally, that vaso-motor impulses arise in the cord as low as the fourth but clinically in man this is to be doubted. The fourth thoracic segment contains clinically, centers for nutrition, sweat, emotions, arm, heart, lungs, mammæ, cilio-spinal, and some describe a center here which when affected, produces chills. These centers consist of groups of nerve cells that control the motor, vaso-motor, secretory, trophic and possibly the sensory impulses to the above named parts of the body. For these centers to be effective they must be well nourished and in close connection with the parts supplied, that is the reflex arc must be intact. The activity of the nerve cells is controlled by the efferent as well as afferent impulses

reaching them and the degree of nourishment furnished them. The lesion affects these centers by disturbing the nutrition of the cells by exerting pressure on the vessels that supply and drain this part of the spinal cord. This disturbs nutrition hence is productive of disorders of one or more of these centers.

Osteopathically, a lesion of the fourth dorsal is associated with certain effects that are fairly constant. Named in order of their importance and frequency we have: malnutrition, functional heart affections and lung disturbances; other diseases such as pleurisy, spinal cord affections in which the fourth segment is involved, mastitis and other mammary diseases, weakness of the muscles in relation and disturbances of the spinal column such as Pott's disease and curvature sometimes result.

Malnutrition is the most constant effect of a lesion of the fourth dorsal. The form of lesion most frequent is an anterior condition characterized by softness, tenderness and a smooth rounded condition of the tip of the spinous process. The most significant change and sign is the anterior position. The explanation of the general effect lies in the fact that the lungs which purify the blood, the heart which propels the blood, and the stomach and liver which furnish nutrition to the blood, are all innervated, at least in part, by the fourth thoracic segment of the spinal cord. Malnutrition is usually mostly due to lack of, that is imperfect, oxygenation of the blood. Blood to be healthy must have oxygen. This is furnished the blood by the lungs. If the lungs are not active, the amount of oxygen furnished the lungs is decreased in proportion to the weakening of the lung. On account of this, intercurrent diseases are more fatal. The lungs can not meet the requirements. A person with weak lungs is anemic and malnourished. If such a person contracts disease, the chances of recovery are lessened in proportion to the weakness of the lungs. The lesion of the fourth thoracic vertebra weakens the lungs by interfering with (1) the circulation to and through the fourth thoracic segment of the spinal cord in which are located some of the vaso-motor and trophic centers, and (2) by interfering with the transmission of these impulses since the intervertebral foramen is lessened either directly by change in position of bone, or by ligamentous thickening. The impulses pass over the anterior nerve root into the common trunk, thence over the white ramus into the ganglion, then out over the rami efferentes to the pulmonary plexus. Malnutrition is most marked in the young. There are, of course, other causes such as

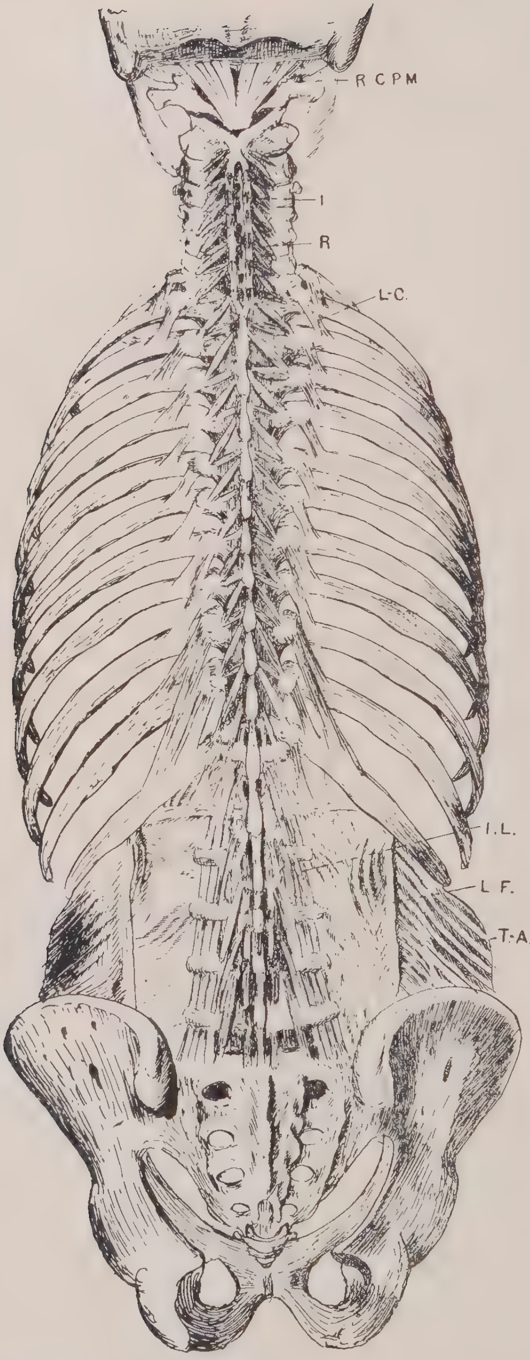

FIG. 42.—Showing the deep, short muscles of the back, (after Spalteholz). Note the direction of the fibers and effect of contracture on position of vertebral end of rib.

imperfect respiration and bad air. One writer has stated, and I think truthfully, that tuberculosis of the lung was "a disease of the lazy," meaning that the lungs were not used properly, deep breathing being too much of an effort.

If the heart is weakened it does not properly propel the blood around the vascular circuit and the circulation is lessened in rapidity. This causes impure blood because of imperfect elimination and increased formation of toxic material. One's vitality is measured by the condition of the blood. A sluggish circulation implies poor blood, hence a lowered vitality.

The other cause of malnutrition, that is an interference with absorption of food, is perhaps not so important as the two named above. This may occur independently of a lesion of the vertebræ, viz., from dietetic errors, yet such lesions make it possible for slight indiscretions of diet to produce marked effects. In all cases of anemia, defects in development of this part of the vertebral column, and back, shortness of breath on exertion, in fact in any form of malnutrition, examine carefully for a lesion of the fourth dorsal.

The **cardiac disturbances** are most commonly functional, occasionally organic diseases follow. Arrhythmia is the most frequent of these effects. The heart beats regularly for a few moments then apparently, if not in reality, loses a beat. The explanation is that the nerve feed to the heart that is, the motor impulses **do not regularly reach the heart.** A muscle responds to the various changes in the nerve impulses. These impulses supplying the heart arise in part from centers located in the fourth thoracic segment. They pass to the heart via the anterior root, common nerve, white ramus, gangliated cord, thence up to the stellate and cervical sympathetic nerves, then over the cardiac branches or directly across by way of the rami efferentes. This lesion affects the origin of the impulses or the nerve transmitting them. The former is affected by way of the blood supply to the segment; the latter in the intervertebral foramen which is lessened in size by the lesion and through which the nerve fibers pass that carry impulses to the heart. The pressure on the nerves carrying the impulses to the heart is the better explanation.

Palpitation is explained in a similar way. The lesion obstructs the transmitting of cardiac impulses. The nerve force seems to accumulate back of the obstruction and finally overcomes it. The heart then re-

sponds to the accumulated impulses. This is soon exhausted and the heart lessens in rapidity in proportion. Again the cardiac centers may be unstable from lesions involving them or from impure blood on account of which the nerve cells are improperly nourished. In exercise, the heart beats rapidly in order to force blood to the lung for oxygenation as rapidly as it becomes deteriorated from katabolism. Fright may cause palpitation, if the heart is irritable, as is often the case when it is weak. Its tone and strength depend on the condition of the centers and the line of communication reaching from these centers to the heart. If they are weakened from any cause, and a lesion of the fourth dorsal is the most common, any exciting cause such as a displaced uterus, distended stomach, exercise or fright will have the greatest effect on the weakest organ; in this case, the heart.

Bradycardia is the result of an impairment of the cardiac centers. This impairment may be from a lesion or from some disease as the profound toxemia from diphtheria. Tachycardia is indicative of a weak, irritable heart. It seems to be in such a nervous condition that any exciting cause may markedly increase the pulse rate. The lesion of the fourth dorsal predisposes the heart to such diseases by interfering with its nerve mechanism described above, thus leaving it in a weak, irritable and nervous condition. In cases of Bright's disease the heart may become very rapid.

The "smothered feeling" is sometimes due to a lesion of the fourth dorsal but more commonly due to a displacement of the fourth rib on the left side. Angina pectoris, of which the above is a symptom, is the result of a similar lesion. Hypertrophy sometimes follows a lesion of the fourth dorsal which has an irritative effect on the cardiac centers or nerves. Organic heart troubles in most cases, follow lesions of the upper thoracic vertebræ or ribs on the left side. Rheumatic fever is given the credit of producing most cases. It is the exciting cause. The writer has carried many patients through attacks of acute rheumatism without cardiac complications. In these cases care was used to correct and keep corrected, all lesions that would affect the heart. I believe that organic heart disease, that is endocarditis, can be prevented by such treatments, that is by correcting all lesions that would affect the innervation of the heart. The explanation is that these lesions so weaken the heart that the fever, with its toxic products, the more readily affect the valves and thus interfere with the nutrition of the heart muscle.

Some diseases of the heart result from a vaso-motor disturbance of the nerves of its blood-vessels. The coronary artery and its ramifications supply the heart. This artery is controlled presumably, by the coronary plexus, which in turn is governed by centers in the thoracic spinal cord. The impulses reach the coronary plexus by way of the cardiac plexus. The vaso-motor supply of the heart has not been definitely demonstrated. A lesion of the fourth dorsal impairs the transmission of these impulses by lessening the size of the intervertebral foramina.

Remember that the **heart is a muscle.** Muscle fibers contract when their nerves are stimulated and relax when inhibited. There must be a center for control, and there must be a line over which impulses pass from the center to the muscle. A lesion of the fourth dorsal affects both. There may be a stimulation or inhibition, at least there will be a pathological effect from such disturbances of the cardiac nerves and centers.

The lungs are weakened by a lesion of the fourth dorsal because the nerves supplying them pass through the intervertebral foramina. After the lung is thus weakened any disease to which it is subject, the more readily sets in; in fact, microbic diseases of the lung would not occur if the viscus were not first weakened.

Summary. Lesions of the fourth dorsal should be suspected in malnutrition, heart diseases, lung diseases, mammary affections, atrophy of one arm, in some cases of stomach disorder, localized pain over this region; in short, disease of any part innervated by the fourth thoracic spinal segment.

THE FIFTH THORACIC.

The **fifth thoracic vertebra** differs slightly from the fourth in that the spinous process is a little longer, more oblique and more distinctly hooked or clubbed. The **superior facets** face almost directly backwards and are as a rule, plane surfaces. The foramina are partly formed by these articular processes **and the least deviation in position of these processes** would cause a change in size of the foramina; either the lower or upper foramina are lessened in size. The same remarks that were made concerning the frequency and cause of lesion of the fourth will apply to the fifth. **Mobility** of this part of the spinal column is very slight. This part acts as a sort of pivot, the movements above, that is in the upper thoracic and cervical regions, being marked, as are the movements of the lumbar spine.

Contractured muscles in this area, can scarcely be relieved by physical exercises on the part of the patient. Such contractures are less common in the more movable parts of the spinal column. Movement of the parts tends to relieve such conditions, hence when such occur in the region of the fifth thoracic, they are not much affected by ordinary exercises since movement of the spine at this point, is slight.

Lesions of the fifth result ordinarily from one of two causes: Contractured muscles from, thermic or other influences; or from trauma. The most common form of trauma is a sudden, unexpected bend in this part of the spine. This sort of injury produces a sprain of the ligaments, some serous exudation, disturbance of the intervertebral discs, especially those connecting the articular processes, contracture of muscles attached and a lessening in size of the intervertebral foramina. This form is characterized by pain on movement or what is often called, a stitch in the back, which in favorable cases gradually disappears. In a vast majority of cases it furnishes the starting point for diseases of the spinal cord in this region, the spinal column and the stomach. The **supraspinous ligament,** on account of its position, seems to be affected more than the other vertebral ligaments. It thickens, softens and remains tender and compressable for quite a while. After awhile it shortens, this helping to produce approximation of the vertebræ as in a stiff or rigid spine.

The commonest lesion of the fifth is an anterior subluxation caused by a forward rotation of the upper part of the vertebra. This would cause an **approximation of the spines of the fourth and fifth dorsal.** From this it may be inferred that in a case of a break in the spine, the vertebra immediately above the break is the one at fault unless one part of the spinal column is turned, twisted or otherwise displaced on the part below. The latter is, in my opinion, by far the most common form of spinal lesion in which there is irregularity. In treating such conditions, the part below should be grasped and held firmly while the part above is used as a lever, thereby restoring normal relation between the two portions.

The **muscles** directly involved are the erector and multifidus spinæ, rotatores spinæ and the levatores costarum. These muscles in the typical lesion, become contractured and as a result, their origins and insertions are approximated to a pathological degree. The bony framework becomes warped, as it were; that is, secondary bony lesions form.

These muscles remain tender and can be readily palpated, remaining cord-like. These contractures interfere with the circulation of blood through them and through the intervertebral foramina. Congestion or arterial anemia of the spinal cord follows the latter. In some forms of lesions the muscles undergo atrophy.

The **veins** passing out through the fifth intervertebral thoracic foramen, empty into the intercostal after uniting with the veins that drain the muscles in relation. The blood then on the left side, usually passes into the left upper azygos veins thence to the heart by way of the vena azygos major and superior vena cava. The blood from the right intercostal, passes directly into the vena azygos major. These veins are subject to pressure from enlargement of the lungs, stomach, intestines and liver. Congestion of the lungs interferes with the passing of blood through these veins, by exerting pressure directly on them, **especially the left azygi veins, because they cross the bodies of the vertebræ.** In all diseases of the above named viscera in which the size of the viscus is increased, the patient should **lie as much as possible in the ventral or lateral position.** If the ventral position is not assumed at least daily, congestion of the spinal muscles and particularly the spinal cord, follows. This in turn coupled with the toxemia resulting from the disease, often produces a form of paralysis. Post-typhoid paralysis is a good illustration of paralysis, from in part at least, faulty posture.

The **arterial** circulation through the parts in relation with the fifth dorsal is affected by a lesion of this bone. The arteries in relation are the intercostal and their branches, the principal one being the dorsal, which divides into the muscular and spinal. The spinal branch is given off first, hence in muscular contractures, which obstruct the muscular branch, the blood backs up into the spinal branch, thus congesting the spinal cord and especially the fifth segment.

The **nerves** that would be involved by a lesion of the fifth dorsal are the fifth thoracic, its anterior or intercostal and its posterior branches, the recurrent meningeal, the grey and white rami communicantes, the fifth thoracic sympathetic ganglion and its branches and the gangliated cord.

The nerves that pass through the fifth thoracic intervertebral foramen are the **fifth dorsal** and the **recurrent meningeal.** The trunk of the fifth dorsal contains fibers that transmit all of the kinds of impulses peculiar to this region. Motor impulses pass out over this nerve to the

following muscles: Intercostals, levatores costarum, obliquus externus, rectus abdominis, erector spinæ, rotatores spinæ and multifidus spinæ. These impulses may be augmented or decreased by the lesion of the fifth dorsal vertebra. As a result of increase in intensity of impulses, the movements of the chest, back and abdomen are impaired. The ribs are pulled upward at the vertebral end, the spinal column curved laterally since these muscular contractures are seldom equal on both sides, and the abdominal wall is made tense. These changes are common but result oftener as reflexes from visceral disease than directly from the fifth dorsal lesion. If the impulses are inhibited or interrupted the above named muscles atrophy to a certain extent, but not very markedly since this nerve, that is the fifth dorsal, furnishes only a part of the innervation of them. There seems to be in typical cases, a contracture of a portion of the erector spinæ and a relaxation of the rectus abdominis and oblique muscles.

The common trunk of the fifth dorsal contains fibers over which pass the **accelerator** impulses, the nerves being called the cardiac accelerators. Their course is similar to those described under the other upper thoracic cardiac accelerators, (which see). Clinically, these fibers are often involved by a lesion of the fifth dorsal, and a lesion of this vertebra is expected in most cases of cardiac disturbance.

The **pulmonary** vessels receive vaso-motor impulses from the fifth thoracic segment of the spinal cord. These impulses pass out over fibers contained in the ventral root of the fifth dorsal, the common trunk, white ramus, ganglion, and the efferent pulmonary. It seems that these impulses leave the gangliated cord at points above the fifth. If the lesion interrupts the impulses passing over these fibers, the pulmonary vessels will dilate. This causes congestion. The circulation of blood is lessened in rapidity, oxygenation interfered with and systemic as well as local disorder, is the result. If these impulses are augmented there will be constriction of the pulmonary blood-vessels, the blood pressure is increased and the lung becomes pathologically anemic. The first is the usual effect, that is congestion, with its tendency to pneumonia and tuberculosis.

By experiments on the dog, it has been determined that vaso-motor impulses to the blood-vessels of the arm arise in the fifth dorsal segment and reach the arm by way of the ventral root, common trunk, anterior division, white ramus, gangliated cord and the brachial, or the sub-

clavian plexus. In man we find clinical evidence that proves that the nerve centers and conducting tracts are similar to, if not identical with, the above. A lesion of the fifth dorsal will in many cases, cause monoplegia of the arm. The explanation is that the lesion lessens the size of the intervertebral foramen through which pass impulses from the center in the spinal cord to the arm. These impulses are supposed to be trophic and vaso-motor.

Vaso-motor impulses to the **abdominal blood-vessels,** arise in the fifth dorsal segment and reach the blood-vessels by way of the great splanchnic. The thoracic blood-vessels are also supplied by way of the thoracic aortic plexus which receives efferent fibers from the upper thoracic ganglia.

Many **sensory impulses** are carried by the fibers contained in the nerve trunk which passes through the fifth dorsal intervertebral foramen. The integument over the fifth interspace and a portion somewhat below the spine of the fifth, are supplied with sensation by the fifth dorsal nerve. The impulses pass to the common trunk by way of the anterior and posterior divisions, thence over the posterior nerve root into the spinal cord, most of the impulses passing across to the opposite side of the cord, thence to the sensorium. Sensory impulses from the pleura, periosteum, peritoneum, and mammary glands, pass to the sensorium in a similar way. The sensorium then refers the pain to the seat of the irritation or the supposed source. For example, stimulation of the nerve trunk or any of the fibers, will cause a pain which is referred to the periphery of the nerve. In lesions of the fifth dorsal or corresponding rib, the fibers conveying sensory impulses, as mentioned above, are pressed on but the painful effect is in the periphery instead of at the point of pressure. From this, it follows that painful affections of the areas described above are, in many cases, due to the vertebral and rib lesions. Anesthesia results if the sensory fibers are inhibited while parasthesia results if the nerve is stimulated by the lesion. These lesions lessen the size of the intervertebral foramina and the effect is determined by the amount of pressure from this change in size, and the kinds of fibers involved.

The **lungs** have a sensory center in the fifth dorsal segment, or rather sensory impulses from the lungs pass through it on their way to the sensorium. The impulses pass by the afferent sympathetic fibers to the gangliated cord thence over the white ramus, posterior root, spinal cord, etc., to the sensorium.

Clinically it seems to be demonstrated, that sensory impulses pass from the stomach to this segment. They are in all probability carried by the great splanchnic nerve. In gastralgia, inhibition at or near the spine of the fifth dorsal, is often sufficient to relieve temporarily.

The **recurrent,** is distributed in a way similar to that of the recurrent nerves described above.

The **grey** filaments carry impulses from the fifth thoracic ganglion to the anterior and posterior divisions of the fifth dorsal nerve. The impulses are mostly efferent in character, the vaso-motor being the most important.

Sensory impulses from the stomach pass over the white ramus. Lesions affecting the ramus may cause pain to be referred to the stomach and other viscera supplied by this segment.

The **white ramus** of the fifth, carries impulses from the spinal cord to the fifth thoracic ganglion. The impulses then go up or down in the gangliated cord or out over the efferent nerve. The impulses carried by the fifth thoracic white ramus, supply the heart, lungs, arms, stomach, and abdominal blood-vessels. They vary in character, some being motor, vaso-motor, secretory, trophic and viscero-inhibitory. The motor supply, the heart; the vaso-motor the pulmonary and abdominal blood-vessels; the secretory the gastric glands; the trophic the muscles in relation and those of the arm; the viscero-inhibitory, the stomach.

A lesion of the fifth dorsal, that is a slight displacement or subluxation, will affect the white ramus in most instances. Perversion of function follows, the particular effect being determined by the fibers affected and the degree of pressure or other disturbance of them. **Pressure** on these filaments is the usual cause of disturbance of their function. The filaments composing the white ramus pass on uninterruptedly from the spinal cord to the sympathetic ganglion, forming a part of the ventral nerve root, common trunk and anterior division. The foramen through which these filaments pass is lessened in size by certain forms of lesions of the fifth thoracic vertebra, therefore the impulses passing over these filaments would be affected in some way.

The **fifth thoracic sympathetic ganglion** is adjacent to the fifth dorsal vertebra and would be involved in most cases. The effects of disturbance of this ganglion are similar to that from disturbances of the white ramus, since all the impulses carried by the white ramus pass into, and most of them through, the corresponding ganglion. Some cells

are located in this ganglion which generate impulses, viz., those carried by the grey rami. These would be disturbed.

The **great splanchnic nerve** is the principal branch of this ganglion. It is formed by the union of roots that branch from the thoracic ganglia from the fifth to the ninth. Quain says: "The trunk thus constituted,

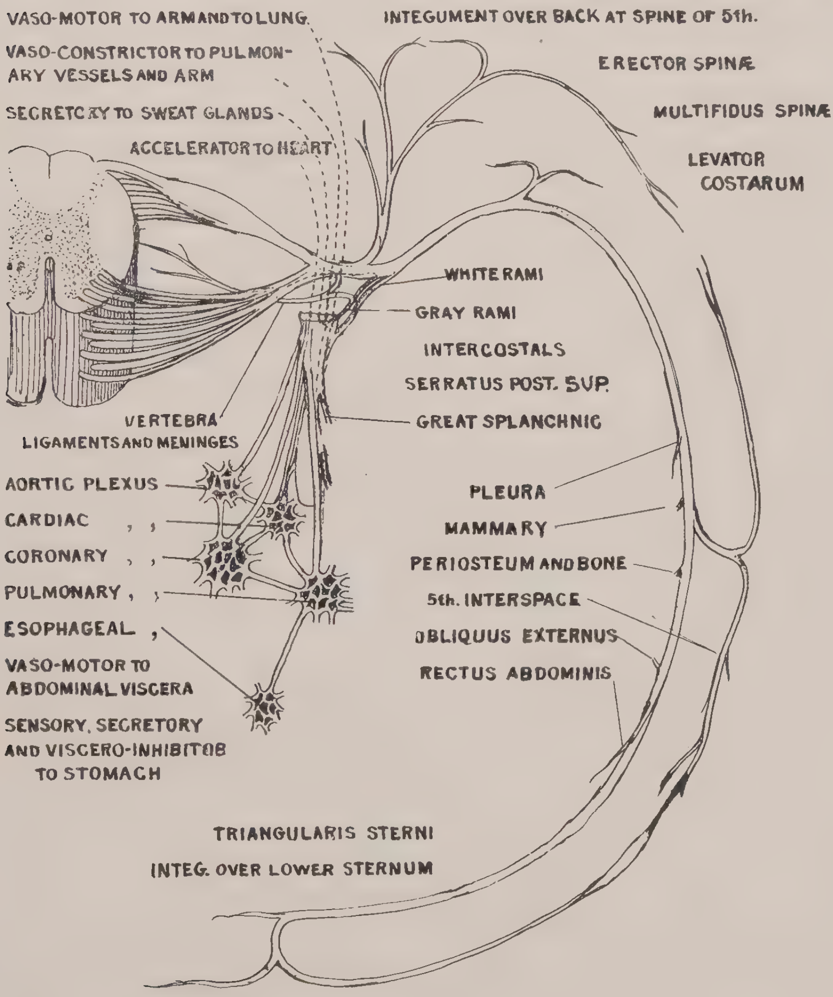

Fig. 43.—The fifth thoracic segment, with its nerves and their distribution.

descends obliquely forward over the bodies of the dorsal vertebræ, and after perforating the crus of the diaphragm terminates in the upper part of the semilunar ganglion; some of the fibers may occasionally be followed to the supra-renal body and the renal plexus. This nerve is remarkable from its white color and firmness due to it consisting in large part (four-fifths according to Rudinger) of medullated fibers, which are continued directly from the spinal nerves; from the highest root they may be traced upward along the sympathetic cord as far as the third thoracic ganglion and nerve, or even higher." This nerve gives off filaments that supply the esophagus, aorta and terminates in the solar plexus. The impulses passing from the fifth dorsal ganglion over the upper root forming this nerve go principally to the stomach supplying it with motor, secretory, vaso-motor, trophic and viscero-inhibitory impulses. A lesion of the articulations of the fifth dorsal will affect this nerve in nearly every instance. In one case there may be a motor disturbance, in another a secretory or vaso-motor derangement. The explanation is that in the one case only the part of the nerve carrying the motor impulses was involved, in the other case the secretory or vaso-motor fibers were affected.

The **great splanchnic nerve** has a variety of functions. It conveys **motor** impulses to the stomach, therefore stimulation of it increases peristalsis. It carries **vaso-motor** impulses to the blood-vessels of the stomach, liver and intestines and especially the **portal vein.** Lesions involving this nerve usually cause a dilatation of these blood-vessels in that the impulses are inhibited. Congestion of the stomach and liver is a very constant effect of a lesion of the fifth dorsal. These conditions lead to many forms of disease. This congestion may at first be arterial but later on becomes venous. Venous congestion of the stomach causes an increase in the amount of gastric juice but its quality is impaired. A catarrhal condition exists. This increased mucous secretion counteracts the hydrochloric acid of the stomach and the gastric juice becomes alkaline. Pepsin acts with difficulty, if at all, in an alkaline medium. Therefore, the food when ingested is not readily digested and it ferments in the stomach. This gives rise to lactic acid. The gas, being acid, gives rise to a burning sensation which is called "heart-burn" since it is referred to the region of the heart. Dyspepsia in all its varying forms, results from some lesion interfering with the transmission of impulses from the spinal cord to the stomach. Errors in diet aggravate the con-

dition and in many cases are alone responsible for the dyspepsia.

A lesion of the fifth dorsal, lessens the size of the foramen through which pass vaso-motor impulses to the stomach by way of the great splanchnic nerve.

Some vascular disturbances of the stomach result from abuse of

FIG. 44.—Showing the great splanchnic nerve, left side, with its roots of origin, the gangliated cord, rami and pulmonary branches. (From photo). The nerves were colored before taking the photo. r, ramus; p. pulmonary branches; 1, 2, 3, 4, 5, roots of the great splanchnic nerve, l. s. lesser splanchnic.

the organ. Errors in diet often cause pathological vascular changes in the walls of the stomach.

*Landois says: The great splanchnic is the **inhibitory** nerve for the intestinal movements, but only so long as the blood in the capillaries has not become venous and the circulation in the intestine remains undisturbed. If the latter condition has arisen, irritation of the splanchnic causes increased peristalsis. If arterial blood be introduced, the inhibitory action is prolonged." Applying this to effects of lesions disturbing the great splanchnic, a disturbed circulation will necessarily result, with either a lessened or increased peristalsis. This nerve is also **sensory** to the stomach and intestines, that is, it is partly afferent and sensory impulses are carried to the spinal cord by it. It is probably a great deal less sensitive than the cerebro-spinal nerves in relation, hence the pain is quite frequently referred to the abdominal or thoracic wall, that is, areas supplied by the fifth intercostal nerve.

A portion of the **peritoneum** is supplied by the great splanchnic. There is a marked sympathy existing between the abdominal wall and the viscera covered by it. A blow on the abdomen will cause vaso-motor paralysis. A painful stimulus applied to the viscus will cause contracture of the abdominal wall.

A few other branches come from the fifth thoracic ganglion: The branches to the **thoracic aortic plexus** and the **vertebræ** and **ligaments.** The gangliated cord is often involved by a lesion of the fifth dorsal. The passing of impulses in such cases along the sympathetic chain would be interfered with. This is not indicated by any definite diseased condition but by a general effect on the viscera receiving impulses that pass along the sympathetic cord.

The **fifth dorsal segment** of the spinal cord contains certain centers that have been fairly well determined clinically and experimentally. The level of the segment is considerably above that of the spine of the fifth dorsal, but the local effects are most marked at and around the spinous process, so when reference is made to a center, the external point or landmark is the spine of the corresponding vertebra. The center for the **nutrition** of the body is partly located in this segment. This is explained above. The **motor, vaso-motor** and **secretory** centers for the stomach are in part located here. This the most important viscus having almost all its centers in this segment. The liver also has a center

(Text-book of Human Physiology, p. 288).

in this segment but the important centers for it are further down the spinal cord. The spleen possibly derives some of its innervation from the fifth dorsal segment. The centers for the accelerator impulses to the heart are partly located in this segment. The fourth dorsal segment is the most important, so far as the innervation of the heart is concerned. **Sweat** centers for the middle thoracic area are in this segment; motor and trophic centers for the muscles innervated by the fifth thoracic nerve are of course, located in this segment.

The **structures** and **viscera** most frequently involved by a lesion of the fifth dorsal are the stomach, liver, pleura, mammary gland, heart, arm, spinal cord and the muscles of the back in relation. The effect on the stomach varies with the character of the lesion and the kind of fibers involved. **Dyspepsia** is the most common effect on the stomach, of a lesion of the fifth dorsal vertebra. This is partly explained above under the head of vaso-motor function of the great splanchnic nerve. Lessened activity of the muscular fibers, that is dilatation with lessened peristalsis, is also common, especially in the chronic types of dyspepsia. The various types of dyspepsia, ulceration, heart-burn, gastralgia, gastroptosis, dilatation, nausea and vomiting, boulimia and in fact any stomach disorder, may follow a lesion of the fifth dorsal. The explanation is, the lesion lessens the size of the foramen through which pass blood and lymph vessels to and from the spinal cord (fifth dorsal segment) also the various nerve filaments over which pass impulses to the stomach by way of the great splanchnic nerve. These impulses are named under the function of this nerve.

Vomiting may be due to several causes. The various muscles of respiration are called into service and the peristalsis of the stomach and duodenum seems to be reversed. The contraction of the abdominal muscles, according to Howell* is believed to be the principal factor in vomiting.

"It was long debated whether the force producing this ejection comes from a strong contraction of the walls of the stomach itself or whether it is due mainly to the action of the walls of the abdomen. A forcible spasmodic contraction of the abdominal muscles takes place, as may easily be observed by any one upon himself, and it is now believed that the contraction of these muscles is the principal factor in vomiting. Magendie found that if the stomach was extirpated and a bladder con-

*Text-book of Physiology, p. 651, 1905.

taining water was substituted in its place and connected with the esophagus, injection of an emetic caused a typical vomiting movement with ejection of the contents of the bladder. Gianuzzi showed, on the other hand, that upon a curarized animal vomiting could not be produced by an emetic—because, apparently, the muscles of the abdomen were paralyzed by the curare."

If the cause lies in the stomach, the vagus furnishes the afferent path. "The efferent paths of the reflex are found in the motor nerves innervating the muscles concerned in the vomiting, namely the vagus, the phrenics and the spinal nerves supplying the abdominal muscles." Clinically, lesions involving the spinal nerves, the fifth and sixth dorsal, being the most important, at least predispose to nausea and vomiting. Morning sickness in pregnancy is made worse by such lesions.

The **liver** is sometimes affected by a lesion of the fifth dorsal. Ordinarily, liver disorders are associated with lesions of the sixth and seventh thoracic vertebræ, under the discussion of which its diseases will be considered. The explanation of why a lesion so high as the fifth would affect the liver is, that the portal vein as well as the other vessels, are supplied by the **splanchnic,** and this nerve would be involved by a lesion of the fifth dorsal, because of its relation to the articulations of the vertebra.

Disorders of the **pleura** result, in some cases, from some form of lesion of the fifth dorsal. The explanation is that the fifth intercostal nerve which supplies in part, the parietal layer of the pleura, is usually involved by a lesion of the fifth dorsal.

Mammary affections are explained in a similar way, that is, by the effect of the lesion on the fifth intercostal.

A few of the **cardiac accelerator** fibers pass out of the fifth dorsal foramen and many pass through the foramen between the fourth and fifth dorsal, therefore heart disease follows lesions of the fifth dorsal, if these fibers are affected by the lesion. Heart and stomach disorders are often found in the same patient. The common lesion explains this peculiarity as well as the proximity of the organs.

The **upper extremities** are often affected by a lesion of the fifth dorsal. The important effect is weakness or atrophy. In some cases complete paralysis follows. The spinal cord is directly involved by pressure if the subluxation or displacement is marked. Paraplegia is the sequel to this, it being the result of the transverse myelitis produced by the subluxation.

Other spinal cord diseases, not depending on direct pressure, come indirectly from these vertebral lesions. The **contour** of this portion of the spine is changed and the **median furrow** is often widened from atrophy of this portion of the erector spinæ muscle.

Chorea in which the arms are mostly involved, comes in some cases as a sequel to a lesion at the fifth dorsal. Cutaneous diseases, neuralgia, "shingles" and in fact any disease of this part of the body, may be the result directly or indirectly, of a lesion of this vertebra.

Summary. The **stomach** is the principal viscus supplied by nerves coming out of the spinal canal in relation with the fifth dorsal, hence the most common visceral effect from a lesion of this bone is stomach disorder. Dietetic errors produce pain and muscular contractures in this region. Some effect on the stomach can be obtained by palliative treatment applied to the spine at this point. This effect is measured by the effect obtained on the medium treated. **To get a stimulating effect** on the stomach **remove the lesion causing the unnatural inhibition. To secure an inhibitory effect on the stomach, remove the lesion causing the increased peristalsis.** In either case the lesion produces the effect through stimulating or otherwise affecting the great splanchnics Sometimes, external treatment will cause a direct effect on the stomach, that is pressure on the spine at the fifth dorsal will lessen peristalsis and stimulation will increase peristalsis. This effect, if obtained at all, is at best only temporary, as stated above. If this pressure or stimulation relaxes the muscles or adjusts the spine or ribs, the stomach will be affected proportionately.

THE SIXTH THORACIC.

The **sixth thoracic vertebra** is similar in most respects, to the vertebræ described above. The spinous process is very long and oblique, reaching to the body of the eighth dorsal. The superior foramina like those of other thoracic vertebræ, are bounded posteriorly by the anterior portion of the articular processes, hence any movement of it would cause some change in size in the foramen. The articular facets are almost plane surfaces. The transverse processes are directed upward, outward and backward and bear facets that are quite deep and concave. The **movements** of this vertebra are very limited and the remarks applied to the fifth dorsal, will apply to the sixth.

Lesions of the articulations of this bone are usually very chronic, con-

sequently, chronic diseases of the stomach and liver follow lesions of this vertebra. This is because the lesion has been overlooked at or soon after its occurrence. The usual signs and symptoms of vertebral lesions are present. **Softening and thickening** of the supra-spinous ligament are the most important signs. **Tenderness** over the spine and some irregularity are usually present. As is the case of lesions of most single vertebræ, the bone is anterior more commonly than all other displacements combined.

The **ligaments** and **muscles** attached to it are affected if only one side is involved. A scoliosis quite commonly develops. If anterior, a lordosis may follow.

The **azygi veins** are subject to injury from subluxations of the vertebra and from enlargements of adjacent viscera. The lateral spinal vein is affected in a way similar to that of other lateral spinal veins. Pressure on it causes congestion of the areas drained by it: the meninges, vertebræ and especially the sixth dorsal segment of the spinal cord.

The **arteries** involved by this lesion are the sixth intercostal and its branches, and through their nerve supply, the thoracic aorta and its branches. The intercostal arteries are obstructed, the muscles of the back contractured and the spinal cord congested.

The intercostal **lymphatic vessels** are also affected by a vertebral lesion. The vessels draining the spinal cord pass from it by way of the intervertebral foramina. From this it can be determined why they are disturbed in function. Their function is not well understood. Edema of the part drained seems to be the most constant effect of a disturbance of the lymph vessel.

The **nerves** are affected in a way similar to that from other vertebral lesions. The muscular branches supplying the intercostal, levatores costarum, obliquus externus, rectus abdominis, and the erector, multifidus and rotatores spinæ muscles are at least affected in part. The most constant effect is on the erector spinæ and levatores costarum muscles. The erector spinæ mass at first contracts but later on undergoes atrophy; this producing a local widening of the median furrow of the spine. The levatores costarum, by their contracture, displace the angle of the ribs upward, this prying or rotating the anterior or sternal end downward.

The **obliquus externus** is either relaxed or contractured. In irritative diseases of the stomach, this muscle becomes contractured and thus

the abdominal wall becomes tense. The patient yields to this contracture and consequently, a stooped posture. In non-irritative disorders of the abdominal organs the muscle becomes relaxed and the viscera descend from lack of support. The same might be said of the rectus abdominis.

The effects on these muscles are so fairly constant that they are diagnostic. They are reflex effects and are explained by the proximity of the cells in the spinal cord that give rise to impulses that supply both the viscera and the muscles. An irritation of the afferent nerves of the stomach causes an increased activity of the cells in the sixth dorsal segment possibly on account of the overflow of impulses, hence congestion. This soon becomes pathological and the motor cells are affected that supply the muscles in relation and **contracture** is the result of the prolonged and unnatural stimulation. In case of **relaxation,** the disorder is a chronic one and the nerve cells are in a sense, paralyzed. In the case of the abdominal muscles, often there are degenerative changes in the muscle itself that are so marked and extensive, that the fibers are permanently shortened or lengthened. The lesion may directly affect both sets of nerves, those innervating the muscles and the viscera, and thus produce pathological effects in both.

The abdominal muscles protect the delicate structures covered by them, contracting firmly and quickly from any expected blow directed against them.

The **sensory** branches of the sixth thoracic nerve, supply sensation to the integument over the pit of the stomach, the sixth interspace and a portion of the integument and tissues at and around the sixth dorsal spine. In subluxations of the sixth dorsal or other disturbance of it, such as fracture or Pott's disease involving it, the pain is often referred to the pit of the stomach. In gastralgia, the greater part of the pain is in the walls of the stomach while some of it is in the abdominal wall.

This is proven by the fact that the pain is intermittent. The pain in colic is due directly to the contraction of the viscus. The contraction is a reflex one and dependent to a great extent on the amount and character of the contents of, in this case, the stomach. The afferent nerves are the great splanchnic and the vagus while the efferent, are the splanchnic and the intercostal. The pain seems to be in the walls of the stomach and is the result of spasm or contracture of the muscle fibers composing the wall, this compressing the nerves in the walls. In some cases possibly the pain is the direct result of a stimulation of the sensory

nerves but I believe this to be the exception especially in gastralgia, or else the pain would be constant. It is possible to get contraction of the muscles of the stomach by direct stimulation after all nerve connections with the spinal cord are severed. This is explained by the presence of intrinsic ganglia in the walls.

In inflammatory diseases of the stomach, this part of the abdominal wall, that is the pit of the stomach, is tender. **Tenderness on pressure at the pit of the stomach** is almost **diagnostic of inflammatory or other organic disease of the stomach.** The explanation is that the same segment that supplies the stomach, supplies the pit of the stomach and the pain is referred to the part supplied by the more highly sensory nerves, the cerebro-spinal. While in other cases, it is due to the inflammation of the pyloric end.

Sensation to the pleura and peritoneum is also directly furnished by this sixth dorsal nerve. The cardiac end of the stomach is supplied with sensation by the sixth nerve, it carrying the impulses to the corresponding segment. The impulses pass from the stomach to the sixth dorsal nerve by way of the great splanchnic.

The **liver** and **gall-bladder** are also supplied with sensation by this nerve and the impulses reach it in a similar way. In acute, painful disturbances of these viscera, the muscles supplied by the same segment become markedly contractured, particularly the spinal muscles, while the abdominal wall, as a rule becomes tender and in acute cases, contracted and tense. Hepatic colic is a good illustration of this point.

Pressure over or at the place of emergence from the spinal canal of the sixth dorsal nerve, may lessen or completely stop the passing of the sensory impulses from the viscus to the spinal cord, thereby relieving the pain. Gastralgia and hepatic colic (mild form) can in most cases, be controlled by such treatment. This treatment is only palliative and relieves temporarily, if at all. By relaxing the contractured muscles of the spine, marked effect can be obtained on the affected viscus. Relaxation is better secured by adjusting the bony lesion rather than by inhibiting the muscle by pressure directly applied to it. The muscular contracture **is the effect** and by relaxing it, although the effect is thus counteracted yet the cause remains. The subluxation of the sixth dorsal, is, in most cases the primary cause of both the visceral and muscular trouble and by correcting it the effects, unless too chronic, will be and remain relieved. If a muscle when contractured undergoes structural

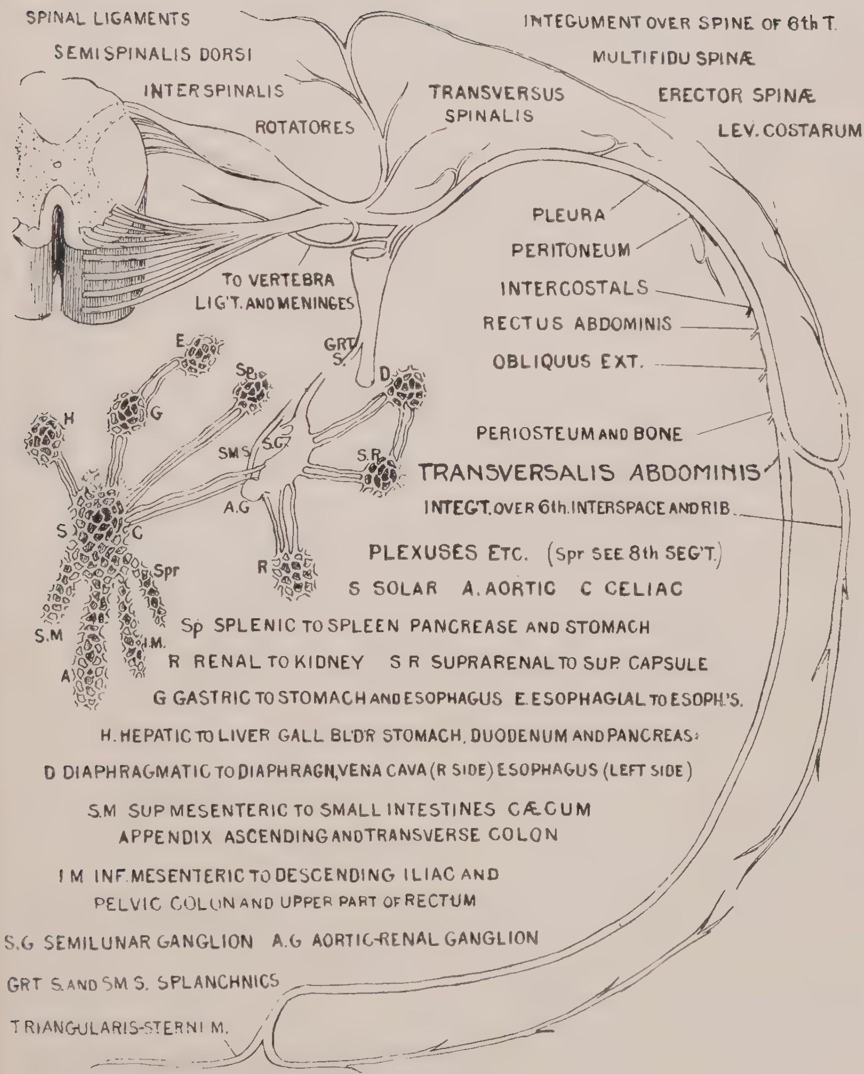

FIG. 45.—The sixth thoracic segment with its nerves and their distribution.

changes that prevent relaxation, stretching of the muscle is to be advised in such cases.

Vaso-motor impulses to the abdominal blood-vessels pass out over the sixth dorsal nerve, the white ramus, sixth thoracic ganglion, and thence to the various vessels by way of the great splanchnic and the solar plexus. The spinal cord, liver, stomach and small intestines are especially supplied with vaso-motor impulses by the sixth dorsal segment. The sixth dorsal ganglion gives origin to one of the roots of the great splanchnic nerve. This nerve has been discussed in part under the fifth dorsal segment. It gives off branches to the thoracic aorta and the œsophagus, before it reaches the solar plexus.

A lesion of the sixth dorsal will affect the spinal cord. The various **centers** in the cord may be involved, such as the center for the tone of muscle, vaso-motor, secretory, viscero-inhibitory, sweat and trophic. These centers may be involved from direct pressure on the cord or from changes in size of the foramina which interfere with the nutrition of the cells. The grey matter in particular, is often affected by lesions occuring in the young. Anterior polio-myelitis can often be traced to a fall or other injury in which the spine is involved. These injuries result in a disturbance of the cells in the anterior horn and the disease known as infantile paralysis, develops. The explanation of the lesion of the thoracic vertebra producing the disease is (1), the nutrition of the cells is cut off, or (2), the nerve tract connecting the cell with the muscle fibre is destroyed. The first explanation is the better since in most cases there are marked vaso-motor changes in the spinal cord. If this congestion does not result in destruction of nerve cells, a cure is possible, but if the cells are destroyed whether by congestion or hemorrhage, a cure is scarcely possible. There are in addition to the bony lesions, exciting causes which act in proportion to the impairment caused by the lesion.

The various columns as well as the cells of the spinal cord, are affected by some forms of lesions of the sixth dorsal. The effect may be from pressure on the cord itself or from pressure on the vessels that nourish and supply these columns. Locomotor ataxia and the paraplegias are examples. Perhaps not all patients suffering with these forms of spinal cord disease have lesions of the vertebræ that can be distinctly palpated, but the vast majority of cases result from vertebral lesions, the sixth dorsal being a common location of the lesion.

In locomotor ataxia, the pressure is exerted directly on the gang-

lion on the posterior nerve root or on the blood-vessels that supply it and the spinal cord. The ganglion is in close relation with the processes that form the intervertebral foramina and are thus subject to pressure if there is the slightest deviation. Although this would of itself produce locomotor ataxia, yet I believe the better explanation is that the spinal cord and its nerves are affected through the disturbance of nutrition caused by these spinal deviations affecting the circulation of the spinal cord and its branches. Syphilis may have something to do with the production of the disease but this as yet has not been demonstrated, only surmised. The toxemia of any disease will make the effect of a spinal lesion on the spinal cord the more marked. The treatment of syphilis by the internal administration of the anti-syphilitic remedies such as mercury and the iodide of potassium is perhaps responsible for the production of the locomotor ataxia in many cases. Excessive coitus is a very important cause of locomotor ataxia. *"When sexual impulses force the concerned ganglionic cells too often, and for too long periods of time, they lose power; and if the state of exhaustion continues without time for physiological recuperation, degeneration is the final result."

This condition plus the spinal lesions are responsible for most if not all cases of tabes dorsalis notwithstanding the statements in the various texts that syphilis is the only cause.

*von Raitz so well expresses my ideas in regard to the cause of tabes, that I quote the following: "Injury to the cord, as an etiological factor of tabes, has of late arrested the attention of unbiased observers, and there is sufficient evidence to force serious consideration of those cases whose history points to accidents after which tabetic symptoms appeared. Injury to the cord may occur without any external evidence, and, as a matter of fact, seemingly trivial accidents are, at times, followed by tabes. Severe traumatism to the spine may cause instantaneous partial or total, transient or permanent paralysis below the level of the injury, but no symptoms of locomotor ataxia, while a simple fall or sharp twist of the spinal column, leaving no external evidence of injury to the spine, and no immediate symptoms referred to the cord, may induce locomotor ataxia. When, after a fall, symptoms appear gradually, they are not understood until locomotor disturbances set in; and even then serious attention is not paid to them, but liniments and antirheumatic remedies are employed until a competent man makes a diagnosis of tabes. If

*Medical Record, p. 650, 1905.

this physician holds to the syphilis theory, he will, under all circumstances find that the patient has had syphilis some time ago, no matter whether he has had symptoms of the disease or not, for, if all evidence fails, the "benefit of the doubt" covers every lack of information. The fall is thrown out as an etiological factor as soon as mentioned, because no explanation of how a fall can cause tabes, has as yet, been offered. Some, however, admit that a fall, while not the cause of the condition, might have hastened the progress of the disease, which was present before the fall.

How a simple fall can cause injury to the cord and subsequently tabes is, however, not difficult to understand. We know, when a blood-vessel is subjected to tension and torsion, it loses its elasticity by over-stretching or rupture of the muscular fibers of its walls. When a person falls, he will, before the body reaches the ground, try to save himself by throwing his weight in the opposite direction. This motion is carried out with great suddenness and with as much power as the person has at his command. The spine is then bent and twisted at the point of greatest flexibility. The anatomical relations of the spinal column allow the greatest freedom of motion in the lumbar spine, and there the center of gravity of the lower part of the body, in its downward course is suddenly met by the weight of the upper part of the body in its opposing direction, thus mitigating the impact of the body with the ground. To oppose the falling of the body still more forcibly, the arms are suddenly thrown out in the opposite direction, and according to the degree of pronation of the upper body, necessary to oppose the fall, a corresponding bending and twisting of the spinal column takes place, during which the blood-vessels are stretched and twisted. If the degree of tension and torsion is greater than the elasticity of the implicated arterial walls can endure the muscular fibers are damaged and the walls may, at one or more points, collapse and obliterate. The portion of the cord concerned will now, sooner or later, suffer for want of nutrition, in proportion to the number or importance of the nutrient arteries involved, and corresponding symptoms of degeneration become, more or less apparent. The progress of degeneration once started, has a tendency to progress, unless checked by forced nutrition, which, no doubt, often enough, takes place in strong individuals. After such injury the spinal nerve fibers or ganglionic cells, or both, may be affected, as this depends on where nutrition ceases, and the first symptoms which present them-

selves are disturbances of locomotion. This class furnishes the motor type of tabes."

This sprain or as we would term it, lesion, may occur in the thoracic as well as in the lumbar region. If the disease were due to syphilis and not dependent on other causes, why is it that only a small per cent. of syphilitic patients contract the disease? In those that do, we believe that the antisyphilitic drugs are as much to be blamed for the production of the disease as the syphilis itself.

A marked lesion or **fracture** of the sixth dorsal will cause transverse myelitis if there is pressure on the spinal cord.

The **contour** of the spinal column is affected in ninety per cent. of cases if the lesion occurs before the growth of the spinal column is completed. These curvatures usually start from a **subluxation** or **strain** of a **single articulation** and get well under way, before they are noticed. The articulations of the sixth dorsal furnish a very common starting point of the trouble. Deviations or sprains of these articulations cause atrophy of the muscles on one side and the opposite side proceeds to draw the spine toward that side and in a year or so a well defined scoliosis is developed.

Pott's disease may set in as a result of a lesion of the sixth dorsal. The explanation is that the lesion lessens the resistance, that is, lowers the vitality of the part, which condition permits of the entrance and propagation of the micro-organisms peculiar to this disease. Care should be exercised in the treatment of such a spine not to use much force since the vertebræ may be badly injured on account of the honey-combed condition of the body of the bone.

A lesion of the sixth dorsal will cause a disturbance of the **ribs articulating** with the transverse processes. The character of the effect is determined by the kind and degree of the vertebral lesion. This is true of all the thoracic vertebræ. In scoliosis with rotation, a marked bulging takes place on the convex side with concavity on the opposite side of the thorax. At first the change in position of the rib produces pain along the intercostal nerve if the subluxation is a sudden one. If it comes on gradually, nature adapts herself to the changes and little or no pain is felt as the rib changes its position.

If the sixth thoracic vertebra is turned toward the right side, the sixth rib on that side will be forced forward while the corresponding one on the left will be carried backward. If the vertebra in displaced di-

rectly forward, both ribs are carried with it and there in a corresponding depression of the shafts of the ribs. In this way a differential diagnosis between a forward displacement of the vertebra and an apparent one, can be made. If the vertebra is displaced backward, the ribs are carried with it and the shafts become more prominent. When the part of the

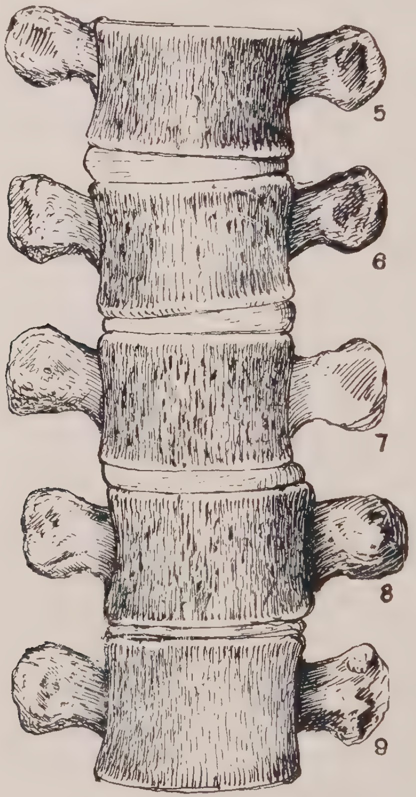

Fig. 46.—Showing effects on disc in lateral subluxation of 5th and 6th thoracic vertebræ. This unequal pressure on the discs is responsible for lateral curvature of the spinal column. Compare with Figs. 48 and 49.

rib in relation with the transverse process of the vertebra is displaced, the shaft, hence the anterior part, is changed as to position. Therefore examine the position of the ribs in making up a diagnosis of the particular form of vertebral lesion if it is in the thoracic area and remember that the

rib lesion, that is displacement, may be secondary. A lesion of a thoracic vertebra will always produce some form of rib lesion but the converse is not necessarily true, that is a rib lesion does not as a rule, produce a perceptible vertebral lesion.

A lesion of the sixth dorsal, if chronic, invariably affects the stomach and **liver.** It may also affect the peritoneum, pleura, diaphragm, pancreas, gall-bladder and small intestines. Only the effect on the liver will be considered at this place. The effect on this organ is primarily that of congestion. This follows because the innervation of its blood-vessels comes from the sixth dorsal segment, the impulses reaching the blood-vessels by way of the splanchnic nerves, solar plexus and hepatic plexus, and these vaso-motor impulses are obstructed by the lesion. Almost all liver disturbances start as a congestion. The functions of the liver are perverted, it becomes heavy and tender, indigestion soon sets in, followed by many and varied discomforts. **Congestion of the liver** increases the amount of formation of bile and seems to lessen excretion and the patient soon becomes bilious. In passive congestion, and this is the most common type of pathological congestion, the quality is impaired with a tendency to a formation of gall stones.

In active congestion of any gland, the quantity of secretion is increased, while the quality is not necessarily affected. In passive congestion there is usually an increased quantity secreted as well as a change in quality. The secretion after awhile becomes thickened, nasal catarrh and leucorrhea being the best examples. It is a well known fact that in colds of the head, there is first a coryza, but afterward the secretion becomes thicker as the disease becomes more chronic. In all probability this is the condition in the liver. That is, in chronic passive congestion the **bile** is not only increased in amount, but **becomes thickened.** The thicker the secretion, the greater the tendency to the formation of a sediment, which is usually preliminary to the formation of gall stones.

A **torpid or sluggish liver** seems to be the predisposing cause of gall-stones, hence the connection between a lesion of the sixth thoracic vertebra and gall-stones. The bile pigment which is increased in amount by this congestion, is absorbed by the lymphatics, and an attempted elimination produces jaundice. The other functions are more or less affected by a lesion of the sixth dorsal because this lesion affects all the nerves going to the liver, particularly the vaso-motor, trophic, secretory and sensory. From these effects come jaundice, gall-stones, indiges-

tion, biliousness, malaria, diabetes mellitus, kidney disease and disorders of the bowels and blood.

In **jaundice** there is excessive secretion of bile, imperfect excretion, absorption by the lymphatic vessels and an attempt on the part of the skin to eliminate the bile pigment. Gall stones result from change in the character of the bile. An **alteration in the composition of the choles-**

FIG. 47.—Showing spine of boy suffering with Pott's disease. Note the knuckle-like enlargement of the 6th dorsal spine. (From photo).

terin, which is supposed to prevent deposit, that is, keep the bile in solution, and **imperfect elimination** either from a sluggish condition of the liver or from obstruction to the bile ducts, acting together, produce gall stones.

Indigestion may be of two forms as a result of liver disorder, gastric and intestinal. The former results because of the congestion of the stomach, which always follows congestion of the liver because **all the blood in the walls of the stomach must pass through the liver before it reaches the heart. Intestinal indigestion** comes from (1) the change in amount and quality of the bile, this hindering intestinal digestion since the bile has a great deal to do with this form of digestion, and (2) from the obstruction to the venous drainage of the small intestine.

Biliousness results from congestion of the liver, as a result of increased secretion of the bile and absorption of it. Nausea and vomiting occur when the bile reaches the stomach.

Malaria results from an impairment of the quality of the blood which commonly follows liver disorders, since the liver has to do with formation of and changes in the blood. This condition permits the malarial toxines to thrive, or at least prevents destruction, by the blood.

Diabetes mellitus follows a disturbance of the glycogenic function of the liver. The sugar is thrown directly into the blood and is excreted by the kidneys. Landois says in speaking of sugar in the blood: "It occurs a few hours after injury to a particular spot (center for the vaso-motor nerves for the liver) on the floor of the lower portion of the fourth ventricle; further after division of the vaso-motor paths in the spinal cord from above downward to the exit of the nerves for the liver, that is to the lumbar portion; in the frog, to the fourth vertebra. Division or paralysis of the vaso-motor conducting paths from the center to the liver results in glycosuria. According to recent researches by Francois Franck and Hallion, the vaso-motor nerves of the liver (for the hepatic artery and the portal vein) arise between the sixth dorsal and second lumbar nerves, and pass through the communicating branches into the splanchnic nerves."*

Clinically, the above has been demonstrated and I quote this since it offers an anatomical explanation of diabetes mellitus.

Lesions affect these nerves, although the effect may not be so marked as that from section of the nerves as in the experiments from which the

*Landois Human Physiology, p. 313, 1904.

above was determined; nevertheless there is an effect as a result of these lesions characterized by dryness of the skin, progressive emaciation, boulimia, thirst, increased secretion of urine which responds to the sugar tests, sweetish breath and taste in mouth, all of which increase in intensity until the patient literally starves to death. We recognize other causes than the one mentioned. that is lesions with the lower thoracic vertebræ, but they are unimportant when compared with the spinal lesions. The vertebræ seem to undergo a change. They become more prominent and the spinous processes seem clubbed, that is enlarged, and the change produces a condition in the spinal column that is almost pathognomonic of the disease.

Kidney diseases follow or complicate liver disorders because of the change in the urea, it being nature's diuretic, and an increase of waste matter, thus throwing more work on the kidneys.

Bowel disorders result from the bile changes, there being a change in amount or quality. Marked odor to the stool is usually due to some abnormality of the bile, since one of its functions is to prevent putrefaction.

The **blood diseases** result because, as stated above, the liver has a great deal to do with elaboration of the blood.

Lesions of the sixth dorsal, produce these effects, as explained above, because the various impulses to the liver arise in part in the sixth dorsal segment, pass over the roots of the sixth dorsal nerves, thence over the great splanchnic to the liver, and these lesions interfere either with the **center, or the nerves connecting center and liver.** These interferences result mostly from a **lessening in size of the intervertebral foramen** through which **nutrition** in part, is **carried to the spinal centers** and through which all **impulses that go from the spinal cord to the liver must pass.** Indirectly the liver may be affected by a lesion impairing the action of the diaphragm, stomach and small intestines.

Summary. Lesions of the sixth dorsal may produce dyspepsia, gall-stones, jaundice, pleurisy, peritonitis, gastralgia, intercostal neuralgia, spinal cord diseases, spinal affections and diaphragmatic disturbances.

THE SEVENTH THORACIC.

The **seventh thoracic,** differs so little from those described above that it does not merit separate description. Its spine is on a level with the inferior angle of the scapula. **Motion** at this point of the spinal column

is very limited although more marked than that of the upper thoracic articulations. The movement is mostly restricted by the ribs. As in the vertebral articulations above, the most frequent movement is an anterior and posterior one as in respiration. Use is made of this to correct anterior deviations. The lungs act as a fulcrum, and then when the

Fig. 48.—Showing a swerving of the spine of the sixth to the right and the spine of the seventh to the left. Compare with Figs. 46 and 49.

spine is flexed and the chest securely braced when the lungs are filled with air, powerful backward pressure is exerted, and after repeated attempts, the anterior condition can, in some cases, be overcome. This anterior condition is common and constitutes a condition hard to relieve. The opposite condition may be present and especially in certain forms of disease, principally diabetes mellitus.

Sprains of the back take place quite commonly at the articulation between the seventh and eighth dorsal. This condition is very painful, movement being almost impossible. The ligaments are partly torn, congested and thickened. If apparent recovery does take place, an irregularity will remain, the foramen is lessened in size and a lessening or complete destruction of mobility results. **Many spinal lesions,** I refer to chronic displacements of vertebræ, **have a sprain as a starting point.** Several vertebræ are usually involved and a change in contour is the result.

The **blood-vessels** passing through the foramina are affected in lesions of the seventh. The **vein** starts in the seventh dorsal segment and after being reinforced, passes downward and outward through the corresponding foramen, thence into the intercostal vein.

The **arteries** branch from the intercostal. The main trunk continues into the muscles. A branch is given off which passes into the foramen and being inclosed by the sheath of dura mater that surrounds the roots of the seventh dorsal nerve, passes obliquely upward to the corresponding segment, hence carries nutrition to this part of the spinal cord.

Lesions of the seventh dorsal ordinarily produce pressure on these vessels. The segment becomes in a measure, congested because the anastomosis is not complete enough to carry blood to and from the cord without there being any effect. After a while the collateral circulation may be established, but in the meantime the functions of this segment are perverted in proportion to the degree of vascular disturbance.

The **nerves** passing through the intervertebral foramina, with their branches, are directly affected and the various nerves with which these connect, are more or less affected indirectly.

The **seventh intercostal,** supplies the intercostal and abdominal muscles, diaphragm, pleura, peritoneum, the seventh rib and its periosteum, and sensation to the pit of the stomach and the seventh interspace. If the lesion **irritates** this nerve, in acute cases there will be a contraction of

the intercostal muscles, or rather an interference with the normal action of these muscles, since contracture is scarcely possible. The diaphragm may be affected. **Hiccough** may develop, which form often ends fatally, or at least runs a course of several days unless stopped by relieving the irritation to this or other intercostal nerves. The abdominal muscles contract and cause the patient to assume a stooped posture. There will be pleurisy and intercostal neuralgia, or there may be neuritis

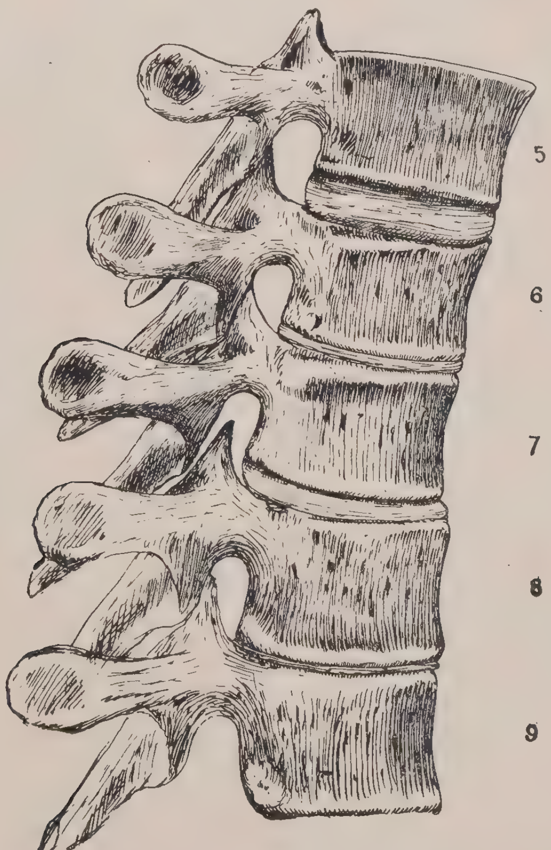

FIG. 49.—Showing effects on the foramina between the 6th and 7th, and 7th and 8th thoracic vertebræ in an anterior rotation of the 7th. The articular process is rotated forward into the lumen of the foramen. Inflammatory deposits fill in the foramina and fix the vertebræ in their abnormal position. Compare with Figs. 46 and 48.

or shingles. Peritonitis, or pain simulating it, will develop, it being most intense on the affected side and in the pit of the stomach. Pain along the course of the nerve is the most common effect, it being the result of congestion of the nerve although it may be a purely referred pain. If the lesion **inhibits,** that is partly paralyzes the nerve, there will be relaxation in the muscles and numbness in the sensory areas. Contracture of the abdominal muscles, upper part, may result reflexly from stomach, pancreatic or liver disorder, or a diseased condition of the small intestines.

Pain in the seventh intercostal nerve may be a referred one from a disordered condition of viscera innervated by the seventh dorsal segment. Therefore, liver complaints, stomach disorders and intestinal affections cause pain, some of which is referred to the seventh intercostal nerve. The lesion of the seventh dorsal may be responsible for the visceral disorder and the referred pain, since the segment may be directly involved by the lesion.

The **posterior division** of the seventh dorsal nerve may be irritated by the lesion. If such is the case the muscles of the back supplied by this nerve become contractured and pain is present in the region of the spine of the seventh. Disease of the liver or stomach will also produce a contracture of these same muscles. Clinically, if the muscles of the back innervated by the seventh dorsal are contractured, there is in all probability, liver or stomach disorder. If the lesion inhibits this nerve, there will be perversion of sensation in this region of the back with relaxation of the muscles supplied. **Visceral disease,** if chronic, will cause **atrophy** of some of the spinal muscles. Liver and stomach disorders, if chronic, cause atrophy of a portion of the erector spinæ muscles in relation with the seventh thoracic spine with widening of the median furrow at that point. Clinically, **widening of the median furrow at the seventh dorsal is diagnostic of chronic liver and stomach disease.** The converse is not always true since there may be disease of the stomach without a widening of the median furrow, but this the exception.

It is stated that the anterior and posterior divisions of the spinal nerve carry vaso-motor, secretory and trophic impulses in addition to motor and sensory. Thermic impulses are also carried by these nerves. Coldness of the integument corresponding to the distribution of an intercostal nerve is quite common in lesions of the corresponding rib or vertebra, and in certain visceral disorders. Stomach disorders are often

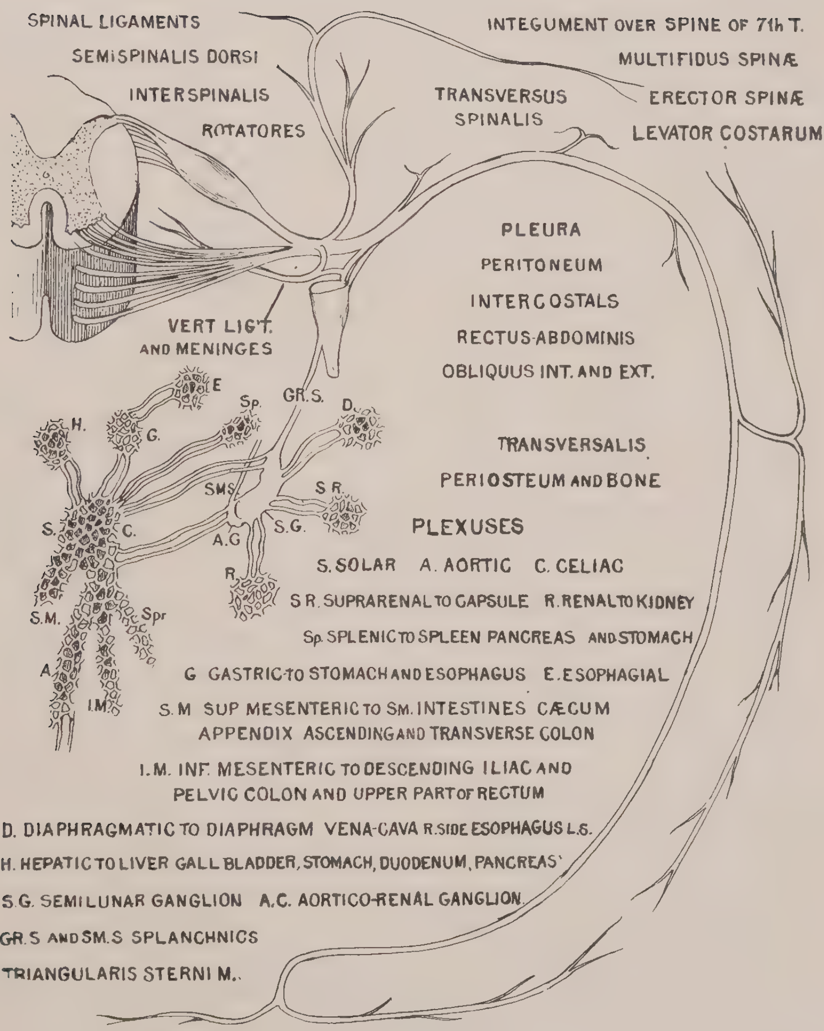

Fig. 50.—Showing the seventh thoracic segment of the spinal cord with its nerves and their distribution.

characterized by a lowered temperature of the integument supplied by the sixth and seventh intercostal nerves.

Perhaps the explanation is that the vitality of this part of the abdominal or thoracic wall is lowered directly by the lesion or reflexly, by the gastric disorder. When the nutrition of a part is below par, the blood stream is slowed and metabolism lessened. In disorders of the stomach, there is a lowering of the vitality of the parts supplied by the same spinal segment and the activity of the parts is lessened, hence the lowered temperature. After all it is a matter of circulation and, in this particular sort of case, the vitality of the wall is lowered on account of (1), a central lesion directly involving the part, and (2), a visceral one that impairs the circulation to that part of the spinal cord that controls the nutrition of, hence circulation of blood through, the affected area.

Vaso-motor changes in the area supplied by the seventh intercostal, are not unusual when a lesion of the vertebra or rib, exists. **Herpes zoster,** is a type of these disorders. If both intercostal nerves are affected, the patient complains of a constriction around the body corresponding in position to the seventh intercostal nerves. Locomotor ataxia is a cause, in which case the lesion is a central one. Lesions of the lower dorsal vertebræ and ribs are more common and important in the production of this peculiar constricting pain.

Practically it may be stated that nearly, if not all diseases of the viscera innervated by the seventh dorsal segment, produce some effect in the areas supplied by the anterior and posterior divisions of the seventh dorsal nerve. The explanation is that the impulses set up by the disorder, pass to the spinal cord which in turn, in most instances, becomes congested. This congestion affects the cerebro-spinal nerves derived from the same segment.

The **rami communicantes** are more or less affected by a lesion of the seventh dorsal. If pressed on, the impulses may be lessened or entirely shut off; and if irritated, they may be increased. The **grey rami** are principally efferent and convey as is the case of those above, vaso-motor, secretory and pilomotor impulses. Undoubtedly some sensory impulses are transmitted by the grey ramus, consequently irritation of the seventh grey ramus would cause pain to be referred to the parts sup-supplied by the great splanchnic and seventh nerves. Inhibition of it would cause vaso-motor disturbances in the cord and abdominal and thoracic walls and lessening of sensation in parts supplied by the seventh thoracic nerves.

If the white rami are affected the various efferent impulses that normally pass over the great splanchnic nerve will be disturbed in some way. It is then possible for there to be perverted peristalsis, secretion, nutrition and blood supply of parts innervated by the nerve filaments in and composing in part, these white rami. The **recurrent meningeal** is in most lesions, affected by direct pressure, hence dilatation of the spinal blood-vessels takes place if the pressure inhibits instead of stimulates the nerve.

The **seventh thoracic sympathetic ganglion** is involved directly or indirectly in all typical lesions of the seventh dorsal. The ganglion lies in relation with the head of the seventh rib. The rib is partly displaced in all lesions of the vertebra. The impulses passing to the seventh ganglion are carried by filaments that pass through the corresponding intervertebral foramen. This foramen is lessened or otherwise affected by a lesion of the seventh dorsal. The branches of this ganglion then would be more or less affected by a lesion of the seventh dorsal. Its branches are the third root of the great splanchnic and branches to the vertebra and ligaments. The great splanchnic gives off branches to the thoracic aortic plexus and the œsophagus before it reaches the solar plexus. If the nerve is irritated by the lesion the œsophagus and aorta may be constricted since it is at least vaso-motor and possibly motor to the esophagus and vaso-motor to the aorta.

Dysphagia sometimes results from a lesion at the seventh dorsal. The other functions of the nerve are more or less affected by the lesion.

The bile duct and gall-bladder are relaxed in the chronic lesion hence tendency to the formation of gall stones because of the incomplete evacuation of the gall-bladder as a result of lessening of the peristalsis. The sediment may form a concretion, which, on account of its character and location, is called a gall stone.

The **spinal column** and **cord** are affected by this lesion in a way similar to that from a lesion of the sixth dorsal, which see. Also the ribs are affected as are other ribs; that is, either a subluxation takes place or else a strain of their ligaments results from the vertebral lesion.

The **liver, stomach, pancreas** and the **small intestines** are the viscera most frequently diseased by a lesion of the seventh dorsal. They are affected because (1) a part of their spinal cord centers is located in the seventh dorsal segment and this segment is invariably disturbed by the lesion; and (2) the line of communication between these centers and the viscus is broken or impaired by the lesion.

The **structures** involved by a lesion of the seventh dorsal are the **peritoneum, pleura, periosteum** of the seventh rib and all tissues attached. The explanation is that the nerve supply to these structures is directly affected by the lesion or else they are affected by contiguity.

The **functions** of the liver are disturbed by this lesion in a way similar to that from the lesion of the sixth dorsal. If the lesion is irritative, there is increased activity up to a certain point after which fatigue sets in and the lesion has the opposite effect. There is disturbance of excretion of bile. It is then retained in the liver, is absorbed by the lymphatics and partly excreted by the skin. This gives rise to biliousness, jaundice, change in character and odor of stool, intestinal indigestion and constipation, because of the change in character of the bile, the abnormal place it occupies and the lessening in amount at the normal place, that is in the intestines. **Biliousness** follows because of the toxemia; **jaundice,** from attempted excretion of the pigment by the skin; the **odor of putrefaction,** since the feces undergo a certain amount of decomposition when the bile is absent; **indigestion** because bile assists in the digestion of the fats; and **constipation** because a lack of bile causes a lack of secretion of mucous and because the parts are not sufficiently lubricated.

The **glycogenic function** is disturbed, this usually resulting in glycosuria. The secretion of urea is altered and kidney diseases develop in a short time if the disturbance is marked. Metabolism is interfered with and the food products carried to the liver by the portal vein are not properly acted on. Most of these effects depend on the vascular changes in the liver. Sensory disorders of the liver also seem to depend on the vascular changes since if it is congested, it is tender on pressure.

Any one or all of the these factors are affected by the lesion, hence the disturbance in function.

Summary. Lesions of the seventh dorsal, cause stomach disorders such as gastritis, gastroptosis, acidity with eructation of gas, gastralgia, or even ulcer and cancer, because the nerves controlling the movement, secretion, nutrition, sensation and the amount of blood, are affected by the lesion, because they pass through the foramina between the seventh and eighth dorsal vertebræ. Diseases of the liver follow a lesion of the seventh dorsal because the amount of blood in it is controlled by the nerves that are impaired by the lesion, viz., the great splanchnic. These diseases vary with the character of the lesion and the function affected.

There may be malaria, kidney disease, cirrhosis, gall stones, glycosuria, and biliousness with periodic headache. A "sluggish" liver with its retention and absorption of bile, is the most common effect. Vomiting is nature's method of relieving bilious headache. In nearly all chronic cases of biliousness seen by the writer, a **marked anterior condition of the sixth, seventh or eighth dorsal vertebra was found.** The explanation is that the lesion causes congestion of the liver by dilating the blood-vessels. There is in all probability, increased secretion of bile and ob-

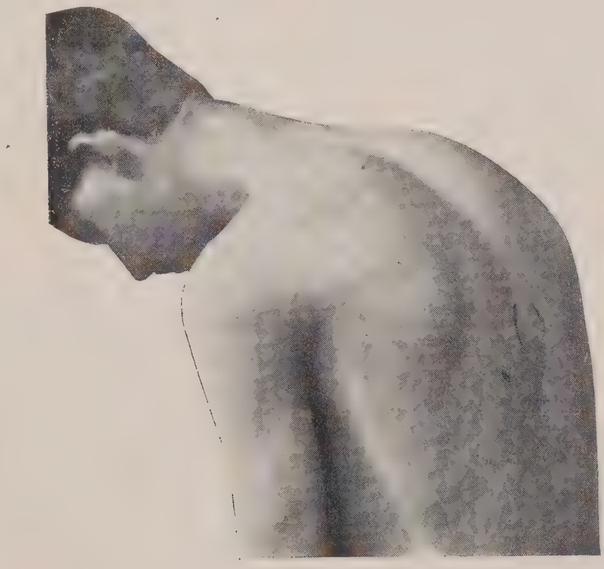

FIG. 51.—Showing a posterior subluxation of the 7th and 8th thoracic vertebræ and an anterior condition of the 9th. (From photo). The patient had congestion of liver.

structed elimination. It then is absorbed and acts as a toxemia. In hepatic colic the sensory nerves involved are the great splanchnic and the sixth, seventh and eighth intercostal nerves. Inhibition, in which **marked pressure is exerted against these vertebræ** (6, 7 and 8) and the body is bent backward, will usually relieve the attack. This sort of treatment lessens the size of the intervertebral foramina thereby interferes with the transmission of the sensory impulses to the sensorium.

Perhaps the effect of this treatment is due in part to the effect on the vaso-motor nerves that also pass through these foramina. By moving the vertebra, it may adjust it so that the normal impulses will again pass through, in which case the treatment is a curative one. Since most pain is due to pressure from congestion, another explanation of why such a treatment relieves even in many cases of colic, is that the circulation through the viscus is bettered, hence the irritation resulting from pressure and chemical stimulation is lessened.

The **pancreas** is also involved by a lesion of the seventh dorsal on account of the resulting disturbance to the great splanchnic nerve, solar and cœliac plexuses. Glycosuria is one effect of a disturbance of the pancreas. The small intestine is often involved by this lesion but not so frequently as by a lesion of the lower thoracic vertebræ. The various lesions of the seventh dorsal, most frequently produce disease of viscera by obstructing the foramen through which impulses pass from the spinal cord centers to the viscera, and through which the corresponding parts of the spinal cord are nourished and drained.

THE EIGHTH THORACIC.

The **eighth dorsal vertebra** does not differ materially from the seventh. The **mobility** of its articulations is slightly more marked because of the change in character of the ribs articulating with it. This is demonstrated best by causing the patient to bend in various directions with the fixed point at the eighth dorsal.

The most common lesion is the anterior subluxation. Many of these come from falls backwards against some object, striking at the eighth dorsal. Extreme flexion may also cause a lesion. **Torsion** is the most common condition of all the lesions of the eighth. The effect is most marked **on the side to which the vertebra is turned.** Such lesions result from a twisting of the body while in extreme flexion or extension.

The **effects vary** with the degree, length of standing, cause, condition of patient and parts affected. The **cutaneous sensory** effect is manifested by sensory disturbances along the eighth interspace, especially in that portion of the abdomen supplied by the seventh and eighth dorsal nerves, and a portion of the integument in relation with and immediately below the spines of the seventh and eighth dorsal vertebræ. The usual effect is **pain,** although there may be anesthesia, coldness of part

or perverted sensation such as formication. These sensory effects vary with the kinds of lesions. If the lesion is an irritative one, pain will be the result; if paralytic, anesthesia follows. Not all pains or other sensory disturbances in those areas are due to a lesion of the eight dorsal. A **rib lesion** of the same side will cause it. **Irritative disease** of the eighth dorsal segment or of viscera supplied by it, will cause sensory disturbances in the areas supplied by the eighth dorsal nerve. **Hepatic colic, intestinal indigestion, liver diseases** such as abscess, and occasionally gastric disturbances will cause pain to be referred to the integument supplied by the eighth dorsal nerve. The explanation is that the impulses set up by the diseased viscus are carried to the spinal cord (8 d. segment) over the great splanchnic nerve, thence over the same nerve tracts that carry impulses from the integument supplied with sensation by nerve filaments that pass through this segment. The sensorium, in such cases of referred pain, is mistaken, as to the real source, and ordinarily refers the impulses to the areas of higher sensibility; or if both visceral and cutaneous impulses travel over the same column or tract of the spinal cord, the pain would also be referred to areas that had the greatest sensory innervation. On this account, lesions of the articulations of the eighth dorsal may produce sensory disorders that simulate the various painful affections of viscera supplied by the eighth dorsal segment.

The **direct cutaneous sensory effects** are due to impingement on or other disturbance of the common trunk of the eighth dorsal nerve or its branches. The subluxated bone ordinarily produces direct pressure on the nerve filaments as they pass through the foramen, at which place they are in relation with the articular processes of the vertebra. If the pressure is marked, there will anesthesia; if intermittent, pain or perversion of sensation. In many cases, especially in mild ones, the pressure is exerted indirectly on the nerve.

Certain **structures** supplied with sensation by nerves that pass through the eighth dorsal segment, are affected by a lesion of the eighth dorsal vertebra. These structures are the **peritoneum,** pleura, eighth rib and periosteum, certain **muscles,** that is muscles supplied by the eighth dorsal segment, **esophagus,** and the **gall-bladder** and **ducts**. The explanation is that the sensory impulses, in part if not entirely, from these structures must pass through the seventh and eighth intervertebral foramina which are changed in size by the lesion. Even though the impulses safely reach the spinal cord, the columns of the cord that

have to do with transmitting sensory impulses, may be affected by the lesion and consequently there will be some sensory effect in parts supplied. The kind of effect varies, as does any sensory effect, with the kind and number of impulses and the condition of the cells receiving them. In the above, **pain** or **hyperesthesia** is the rule, hence a lesion of the eighth dorsal may and often does simulate peritonitis, muscular rheumatism and hepatic colic. The explanation of cause and effect is that the above named structures are innervated in part by the eighth dorsal segment which controls sensation to them through the eighth intercostal nerve, posterior division of the eighth dorsal and the great splanchnic nerve. In such cases it is the rule for the nerve to be congested or inflamed. Certain viscera manifest sensory disturbances when the eighth dorsal vertebra is subluxated, viz., the liver, stomach, small intestines and possibly the spleen and pancreas. They are affected because their sensory nerves, that is the branches of the great splanchnic, are in relation with the eighth dorsal or rather, the filaments that carry impulses to and from it are in relation and are always affected in typical lesions. This disturbance in the viscera gives rise to colic, hence in such affections examine for a vertebral lesion.

The **motor** effects of a lesion of the eighth dorsal, are manifested in the structures and viscera supplied by the seventh and eighth dorsal segments. There may be increased or lessened motion, this depending on the character and degree of the lesion. In acute cases, the muscles are contractured; in chronic ones, the opposite condition is the more common or else there are structural changes in the muscles from which they become shortened and hardened. The **muscles involved** are the intercostals, levatores costarum, obliqui abdominales, recti and transversales abdominales, erector, multifidus and rotatores spinæ and the diaphragm.

The **intercostal** muscles do not become contractured although they may become quite tender from congestion. This makes respiration painful, hence difficult. These muscles often atrophy as a result of the lesion, in which case the respiration is carried on almost entirely by means of the diaphragm.

The **levator costæ** muscle, if contractured, will draw up the angle of the rib; if weakened, will permit the angle of the rib to descend. The muscle will be affected one way or other if the lesion affects its nerve supply or attachments.

The **abdominal muscles** are usually symmetrically affected, that is,

there is either a general relaxation or contraction. If the lesion is irritative, the muscles contract, but if inhibitive, they relax. **The condition of these muscles is a good index to the condition of the viscera covered by them.** In chronic intestinal indigestion, they are usually contractured; in gastroptosis, enteroptosis and especially in chronic constipation, they are relaxed. Vertebral lesions are in most cases, responsible for both the contractured or relaxed condition and the visceral disorder.

The **erector, multifidus** and **rotatores spinæ** muscles are usually contractured by a lesion of the eighth dorsal. In cases of malnutrition they will be relaxed. Their contracture, especially that of the erector and rotatores spinæ muscles, lead to spinal curvatures. If only one side is involved, a scoliosis with rotation. But on the other hand it must not be forgotten that curvature comes **most frequently from relaxation,** hence these apparently contractured muscles, pull the spine to the opposite or convex side.

The function of the **diaphragm** may be seriously interfered with by a lesion of the eighth dorsal, because such a lesion often affects the eighth intercostal which assists in the innervation of the diaphragm. Respiratory disturbances, and the supposed "liver cough" follow.

These muscles named above are supplied by the anterior and posterior divisions of the eighth dorsal nerve. This nerve is affected by lesions of the eighth dorsal, because the foramen through which it passes is lessened in size, or at least, either the seventh or eighth intervertebral foramen is always affected by a lesion of the eighth dorsal vertebra. This lesion also affects the spinal cord, the eighth dorsal segment, especially the cells that give rise to the filaments that form the nerves supplying the muscles named above.

The **motor** and **viscero-inhibitor** nerves to the **stomach** are in part, in relation with the eighth dorsal vertebra and are affected by a subluxation of the vertebra. As a result of this impairment, the peristalsis of the stomach is perverted. If excessive, ulcers are likely to form since the stomach attempts to digest itself. There is a sense of hunger usually described as a "gnawing" sensation. If the peristalsis is lessened, digestion is retarded, and fermentation of the food follows. If reversed, vomiting occurs. In ordinary cases of catarrh of the stomach, there is lessened peristalsis. As to whether this is due to an inhibition of the motor or stimulation of the inhibitor nerves, there seems to be considerable doubt. The splanchnic nerve acts as a motor and viscero-inhibitor nerve, hence

the lesion may affect either or both. The effects on the stomach are explained by the fact that the great splanchnic nerve, which after communicating with the vagus supplies the stomach, is disturbed by a lesion of the eighth dorsal vertebra. Nearly all the motor impulses passing over this nerve arise in the spinal cord, pass out over the ventral root into the common nerve thence over the white ramus into the gangliated cord, thence over the efferent or splanchnic nerve to the semi-lunar ganglion. **This line of communication is often broken, or at least crippled,** by the lesion, hence the effect mentioned above.

The motor effect on the **small intestines** is similar to that on the stomach, that is, there is increased, perverted or lessened peristalsis, characterized by diarrhea or griping, vomiting and constipation. The explanation offered in regard to the motor effects on the stomach will apply to the small intestines.

A lesion of the eighth dorsal will also have a motor effect on the **esophagus.** Constriction with dysphagia is the common result. The explanation is that the great splanchnic, sends filaments to the œsophagus and this nerve is involved in subluxations of the eighth dorsal. Most disturbances of the esophagus come from lesions affecting the fifth and sixth roots of the great splanchnic, although a lesion of the eighth dorsal may affect it. This connection explains the correlation of forces in vomiting.

Landois says: "The splanchnic nerve is the motor nerve of the bile ducts and the gall bladder." Osteopathically, lesions involving this nerve cause accumulation of bile and gall stones. Inhibition of this nerve causes relaxation, hence dilatation of the bile ducts Hepatic colic unless due to an attempted passage of a large calculus, is relieved in this way, that is by applying pressure at the eighth, extreme extension of the spine with fixed point at the eighth or by correcting the lesion at the eighth.

The **vaso-motor** effect of a lesion of the eighth dorsal is quite marked on account of the large area innervated and the importance of the blood-vessels that are supplied by this part of the spinal and gangliated cords. The abdominal blood-vessels as a whole, are more or less affected. The vessels of the alimentary tract are innervated by the middle thoracic area. The superficial blood-vessels in this part of the body are nearly always involved and special mention should be made of the portal, renal and splenic vessels. The blood-vessels innervated may be increased

or decreased in size, this being determined by the character of the lesion. If it irritates, the blood-vessels will remain small so long as the stimulation keeps up, but if the lesion inhibits the blood-vessels will become larger. The first condition is followed by anemia, the second by congestion. If the constriction is localized there will be no general rise in blood pressure, but if general, the arterial tension or pressure is increased.

Dilatation of the **superficial arteries** occurs in the erythematous conditions, red neuralgia being a type. Dilatation of the **portal vein** causes congestion of the liver, which condition is characterized by a plethoric, bilious condition. There is a hypersecretion of bile with absorption. Constriction of the vein has the opposite effect.

Dilatation of the **renal veins** is characterized by increase in secretion of urine and later on, by organic disturbances. In interstitial nephritis the opposite condition probably exists. The functions of the spleen are likewise increased or decreased in a similar way. The abdominal vessels are affected through the great splanchnic nerve. Landois says: "Stimulation of the splanchnic nerve causes contraction; its division, dilatation, of all of the intestinal blood-vessels possessing muscle fibers. In the latter event enormous accumulation of blood takes place in the intestinal vessels, so that anemia of other parts of the body results, and in consequence even death may take place from anemia of the medulla oblongata." The superficial blood-vessels are affected because their vaso-motor impulses pass over the grey ramus from the gangliated cord to the cerebro-spinal nerve, thence to the vessels by way of the intercostal nerve and posterior division of the nerve. The nerve tract is broken or otherwise affected by a subluxation of the eighth dorsal, because it is in direct relation.

The **portal vein** is supplied directly by the great splanchnic nerve which is the vaso-motor nerve to the liver. Experimentally, "division or paralysis of the vaso-motor conducting paths from the center to the liver, results in glycosuria." A lesion will have a similar effect, if it inhibits these impulses.

"The passage as rapidly as possible of large amounts of blood through the liver acts most favorably upon the secretion." This is controlled by nerves that are affected by lesions of the eighth dorsal vertebra. If these nerves are affected, faulty secretion of bile follows, hence jaundice or other changes..

The **renal vessels** are affected by a lesion of the eighth dorsal, because it affects the great splanchnic nerve "which contains the vasomotor fibers for the kidney." If the impulses are inhibited the vessels dilate. If it is a localized condition, increased secretion of urine follows; if the rest of the abdominal vaso-motor nerves are paralyzed at the same time, "the secretion of urine diminishes even to the point of complete cessation." The splenic vessels are innervated by the splenic plexus which ultimately receives its impulses from the great splanchnic nerve, hence the explanation of effect of the lesion on it has been given above.

The **secretory** effects of a lesion of the eighth dorsal are manifest in the amount and quality of sweat, urea, glycogen, gastric juice, succus entericus, pancreatic juice and the secretions of the spleen. The secretion of the peritoneum should also be considered in the secretory effects of this lesion.

The amount of sweat secreted seems to depend on things other than secretory nerves. Landois says: "As in the secretion of saliva, vascular nerves are principally active in the secretion of sweat in addition to the true secretory nerves, and most frequently the dilators, as indicated by the sweating when the skin is reddened." However, the sweat fibers may be active even though there is anemia. The lesion produces a disturbance of the sweat glands (1) by affecting the sweat center in the spinal cord, and (2) by affecting the nerve tracts over which these impulses travel from the spinal cord to their destination and (3), by changing the amount and character of the blood supplying the sweat glands. The center is affected through its blood supply, a venous condition stimulating it to greater activity. The nerve tracts are in the cerebro-spinal nerve and its branches. This nerve is always more or less affected by a lesion of the vertebræ in relation. The amount of bile secreted may be increased or decreased as a result of the lesion of the eighth dorsal. As in the production of sweat, the amount of blood must be considered. Landois, in speaking of bile secretion, says: "All procedures that cause contraction of the arteries of the abdomen, such as irritation of the valve of Vieussens, of the inferior cervical ganglion, the hepatic nerves, the splanchnic nerve, the spinal cord, whether directly as by strychnin, or reflexly by irritation of the sensory nerves, diminish the secretion." Osteopathically, a lesion of the eighth dorsal vertebra would have a similar effect because it would irritate the hepatic nerves, splanchnic nerve and spinal cord, hence the secretory effect.

He further says, "All procedures that produce stagnation of blood in the hepatic vessels, such as division of the splanchnic nerves, diabetic puncture, division of the cervical cord, have a like effect."

"Acceleration of the excretion of bile experimentally, follows stimulation of the region of the spinal cord from which the motor nerves (the splanchnic) are derived that supply the bile ducts and gall-bladder." The glycogenic function also depends to a large degree, on the vascular conditions, hence the explanations offered under the head of vaso-motor effects of the lesion, will apply to the secretory effects on the liver, of a lesion of the eighth dorsal.

The great splanchnic controls to a large degree the secretions of the **stomach** and **small intestines.** Lesions of the middle thoracic vertebræ affect this nerve hence the disturbance in secretion. **Catarrh** is the most common effect. Other causes such as thermic changes and dietetic errors are important. The pancreatic juice is affected in quantity by a lesion of the eighth dorsal, because the great splanchnic is affected by it. Landois says in speaking of the secretion of the pancreatic juice: "The nerves are derived from the hepatic, splenic and mesenteric plexuses, to which the pneumogastric and splanchnic nerves send branches. The secretion of the gland is excited by stimulation of the medulla oblongata, of the splenic nerve (feebly) and of the peripheral stump of the pneumogastric." The pancreas is supposed to secrete a ferment that destroys or counteracts the sugar in the blood, thus glycosuria would follow if this ferment were not secreted. This lesion may also affect the secretion of urine but clinically, the lesion that affects urinary secretion is lower in the spine and will be considered later.

Nearly, if not all nerves are supposed to exert **trophic** influences, thus the trophic effects of a lesion of the eighth dorsal, would be determined by the nerves involved and the areas innervated. The effect may be a general one on account of effect on the liver, stomach and pancreas, but is usually localized in a group of muscles. Some forms of skin diseases characterized by desquamation, are due to an interference with the trophic nerve supplying that portion of the integument.

A lesion of the eighth dorsal, affects the **spinal column** and often is the starting place of a spinal curvature. As stated above, some of the spinal muscles are weakened and the opposing muscles draw the spine toward the sound side. The contour of the ribs is also changed since they articulate with the vertebræ.

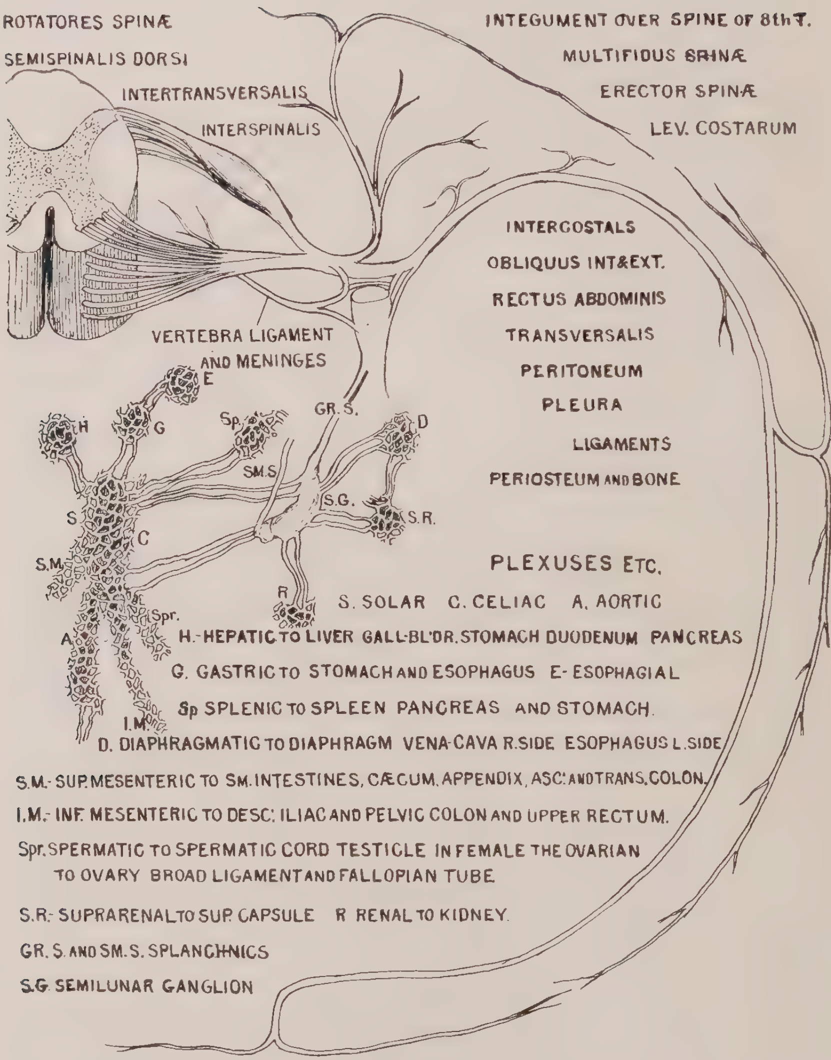

Fig. 52.—Showing the eighth thoracic segment of the spinal cord with its nerves and their distribution.

The effect on the **spinal cord** depends on (1) pressure on the blood-vessels supplying and draining it; (2) pressure on the nerve roots, particularly the posterior, and (3), pressure directly on the spinal cord. The first comes as a result of a lessening in size of the intervertebral foramina, thus directly obstructing the vessels that pass through. The corresponding segment is affected most, since the blood-vessels pass up the sheath of dura mater that encloses the corresponding nerves. Pressure on the posterior nerve roots causes ascending degeneration, locomotor ataxia possibly being the best illustration of the effects. The ganglion is most subject to pressure on account of its location. Pressure on the cord causes transverse myelitis with partial, if not complete paralysis of the body below the level of pressure.

Summary. The eighth dorsal is the **clinical center** for splenic diseases, pancreatic disturbances, gall-stones and intestinal indigestion that is, lesions of it most constantly produce these effects. Biliary and intestinal colic, can ordinarily be relieved by **inhibition at this point,** the treatment being most effectual if the **spine is extended** as far as possible with pressure at this point, that is at the eighth dorsal spine. This movement lessens the size of the foramina through which the afferent impulses pass. Backache is common in this region in lesions of the articulations of the eighth and in kidney, ovarian and intestinal disorders. The prolonged contracture of the spinal muscles in the above conditions gives rise to backache or in acute cases, to lumbago.

THE NINTH THORACIC.

The **ninth thoracic** vertebra is slightly larger than the eighth dorsal, the spine is not as oblique or so hooked. It is classed with the peculiar vertebræ because it has no demi-facets for articulation with the ribs. The mobility of its articulations is greater than that of the eighth dorsal, because of change in character of the ribs. The intervertebral foramina are formed like those above, by the articular processes and are subject to change in size by subluxations of the vertebra. The most common subluxations are torsions and anterior ones. Slight separations such as "breaks" often occur at one of its articulations, that is between the eighth and ninth dorsal or between the ninth and tenth dorsal. Such lesions ordinarily come from hyperflexion of the spine, especially if force is exerted while in the stooped position. The lifting of a heavy weight is often responsible for the separation. The torsion results from an un-

expected twist or turn of the spine. It may at first be diagnosed as a "crick in the back."

The **anterior subluxation** is the most important from a pathological standpoint because of the effect on the foramina, it lessening their size and compressing the structures that pass through them. In all acute or recent cases, the ligaments are either stretched or torn in every pathological case. If torn, they heal slowly and often are markedly thickened. After a while they contract and approximate the vertebræ, thus producing a **smooth** or **stiff** spine. In most cases they remain tender and softened, thus indicating by these conditions the affected vertebra. A separation or break is not so important as an approximation. On testing the mobility of the spine, note that it is **greatest at the widened area** and **lessened or entirely lost at the points of approximation.** As a rule, a separation needs little or no treatment.

All subluxations of the ninth dorsal affect the tissues attached to it. Some are stretched and irritated, others are relaxed and inhibited. The connective tissue is affected and the circulation through it obstructed. The muscles are irritated and soon a contractured condition results. The muscles then begin to ache or act with difficulty. If the patient were to assume a stooped posture for a few minutes. it would be difficult to straighten the spine, the patient complaining of stiffness and an achy feeling. The principal muscles involved are the erector and multifidus spinæ.

The **arteries** affected by a subluxation, are the ninth intercostal and its spinal and muscular branches, the abdominal aorta and its branches that supply the liver, spleen. stomach, small intestines,pancreas, suprarenal capsule, ovary and testicle and the kidney.

The **intercostal** and its branches are affected directly by pressure either by the displaced vertebra, or by traction on, or contraction of, the tissues through which the vessels pass. The **abdominal aorta** and its branches are affected through their nerve supply, that is, by disturbance of the splanchnic nerves which carry vaso-motor impulses to these vessels. Direct pressure on an artery lessens the flow of blood through it by obstructing the lumen. Anastomosis will take place if the arteries are not of the terminal variety. When its nerve supply is disturbed, the artery usually becomes larger, hence the rapidity of the flow of blood is lessened and congestion results. It may become smaller if the lesion is an irritative one, which is occasionally the condition, especially in recent cases.

The **veins** in relation are affected by direct pressure. The veins correspond to the arteries. The inferior vena cava and its branches draining, by way of the portal system, the principal abdominal viscera, are affected through their nerve supply. The most common effect on the vein is dilatation, this producing congestion. In the case of the portal vein, congestion of the abdominal viscera results with its disturbances of function.

The **nerves** affected by this lesion are (1) cerebro-spinal and (2) sympathetic. The cerebro-spinal affected are the ninth thoracic and its branches, the ninth intercostal and the posterior division. The sympathetic nerves affected are the gangliated cord, the ninth thoracic ganglion and its branches, the great and lesser splanchnic, the rami and the branches that supply the ligaments, vertebræ, meninges and spinal cord. Those affected secondarily are the solar plexus and its branches, the semi-lunar ganglia, and the aortic and renal plexuses with their branches.

The impulses that are carried by these nerves pass through the intervertebral foramina in relation with the ninth dorsal vertebra. At least two of these foramina are lessened in size by any form of lesion of the ninth dorsal, therefore the impulses would be impaired. The nerve cells giving rise to these impulses are nourished and drained by blood that passes through these foramina, hence a disturbance of these cells in cases in which the foramina are lessened in size.

The principal abdominal, and some of the pelvic **viscera** are more or less disturbed by a lesion of the ninth dorsal. The viscus most frequently and constantly affected is the **kidney.** This is explained by the fact that it gets most of its nerve impulses from the ninth dorsal segment, while the liver, stomach, etc., are innervated mostly by segments higher in the cord. The kidney is affected then because the lesion interrupts the passing of nerve impulses from the spinal cord to it. These impulses are usually carried by the lesser splanchnic although the great splanchnic carries some. There is a direct line of communication between the cord and the kidney although separate names are given to the different parts of it. The impulses arising in the grey matter of the ninth dorsal segment, pass over the ventral root, common nerve trunk, anterior division, white ramus, ninth dorsal ganglion, lesser splanchnic thence into the aortico-renal ganglion. Sometimes the lesser splanchnic furnishes a direct twig to the renal plexus. Pressure at any point on this line,will disturb the power the nerve has of transmitting impulses,

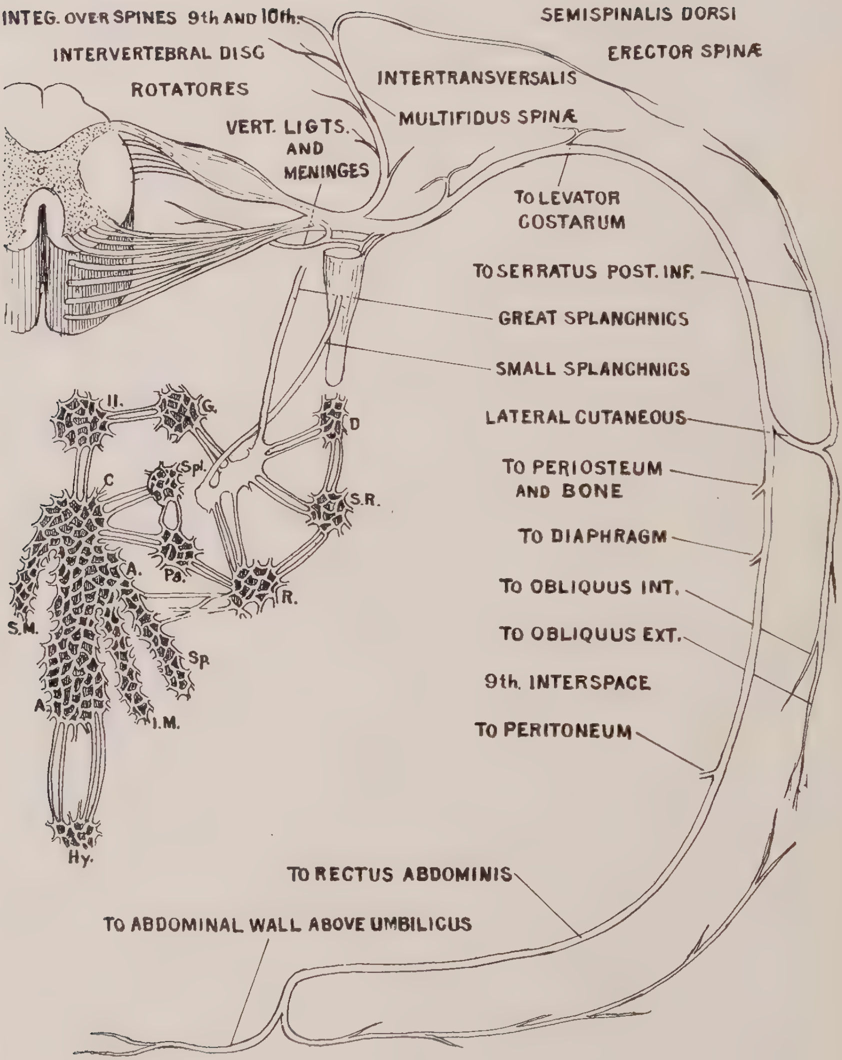

FIG. 53.—Showing the ninth thoracic segment of the spinal cord with its nerves and their distribution.

hence disturbance of function of the part innervated. In a similar way, the kidney may be affected by this lesion interfering with the innervation of its blood-vessels. This nerve supply controls secretion, nutrition, sensation and vaso-motor impulses sent to the blood-vessels of the kidney. If the lesion is irritative, there will be increased secretion, if the secretory nerve is involved, pain referred to the kidney or side,and anemia, if the case is an acute and recent one. Secretion and excretion of urine seem to depend partly on the secretory nerve, blood pressure, and the quality and quantity of blood. If the lesion is paralytic, there will be at first a moderate increase in the amount of urine for a few hours, finally the action of the kidney becomes entirely suspended and an organic disease follows.

The **suprarenal** capsules are affected by a lesion of the ninth dorsal, because their nerve and blood supply are affected by the lesion. The nerve impulses that pass to this organ, at least a majority of them, pass over the lower roots of the splanchnic nerves. These nerves or their roots, are affected by the lesion. The blood-vessels supplying the suprarenal capsule are innervated by the solar, phrenic and renal plexuses which receive most of their impulses from the splanchnic nerves. The lesion may indirectly cause disease of these organs by causing disease of other organs, such as the kidney. As to the effect on the body of a lesion impairing these capsules, little is known. They have to do with the elaboration of the blood, there being an internal secretion.

The **ureter** is, or may be affected by a lesion of the ninth dorsal, because its nerve supply is disturbed. The nerves, motor, sensory and and vaso-motor, that supply the ureter are derived from the renal plexus which in turn is formed by the splanchnic nerves. The ninth dorsal segment contains nerve cells that give rise to filaments that pass directly to the ureter supplying it with motor, vaso-motor and trophic impulses. The efferent impulses pass out of the cord over the ventral root, thence through the intervertebral foramen over the common trunk, then to the ureter by way of the white ramus, gangliated cord, lesser splanchnic and renal plexus. The effects will be considered with the study of the tenth dorsal segment.

The **spleen** is affected by a lesion of the ninth dorsal because the ninth segment sends nerve filaments to it. The principal effect of a lesion involving this nerve seems to be a vaso-motor one. In diseases characterized by splenic trouble, the lesion often is as low as the ninth

dorsal, although the predominating spinal center seems to be higher up in the spinal cord. Schæfer and Moore say that in the dog they found motor nerves to be present in the third thoracic to the first lumbar inclusive. *"The most marked effect was obtained on stimulating the sixth and eighth dorsal nerves; a very distinct contraction on stimulating the fifth, ninth and tenth nerves; a slight contraction on stimulating the third, fourth, eleventh, twelfth and thirteenth thoracic and the first lumbar nerve." Clinically, it can be proven that a lesion will stimulate a nerve. A lesion of the ninth dorsal will stimulate the nerves to the spleen or it may inhibit them, and in most splenic disorders the ninth dorsal is involved.

The **testes** and **ovaries** are involved through their innervation. This comes almost entirely through the renal plexus and lesser splanchnic nerve.

A lesion of the ninth dorsal will interfere with the passing of impulses from the spinal cord to the testicle or ovary since it lessens the size of the intervertebral foramen. The effects will be considered with the tenth dorsal segment.

The **small intestines** are nearly always involved by a lesion of the ninth dorsal, on account of disturbance of the innervation. Indigestion is a common effect. This results from the interference with the sensory, secretory, vaso-motor and motor impulses. **Constipation** results in some cases, on account of interference with the peristalsis of the bowel, it being lessened. **Diarrhea,** even enteritis, follows if the lesion is an irritative one. **Intussusception** may occur.

The **liver** may be involved by a lesion so low, since its blood supply is impaired by such a lesion. Also the stomach is sometimes affected but in such cases the small intestines are also involved, that is, a group of lesions is present, extending from the fifth to the eleventh dorsal. The pyloric end of the stomach is said to be most frequently affected by the lesion.

The principal effect of this lesion (the ninth) is on the vaso-motor nerves innervating the above named viscera. That the viscus is congested or made anemic by the lesion, needs no proof since it has been so frequently demonstrated. As to the explanation, it must be through the vaso-motor nerves or else the congestion would be constant. The lesion alone is usually not sufficient to produce the vascular effects as

*NOTE.—Schæfer's Text-book of Physiology, p. 643, Vol. II.

we find them. The lesion only weakens, then the error in diet, the exposure during the menstrual period or the overwork or any exciting cause, will then bring on the attack. It does not necessarily follow that the lesion produces a pathological congestion or anemia of the viscera that is constant, because the symptoms are irregular; or that there are no lesions present during the interval between the attacks, because there are no apparent indications of them. This applies particularly to ovarian disorders and sick headaches. As stated above, the lesion plus the exciting cause will invariably bring on an attack, whereas if only one cause were present, it would take quite a while for the vitality to become so impaired that an attack would occur, as in the case of a sick headache.

The **diseases** most commonly associated with a lesion of the ninth dorsal are Bright's disease, ovarian disease, diabetes mellitus and insipidus, renal colic and in many cases, biliary calculi. The explanation is that the ninth dorsal segment contains the centers for the above named viscera and connects with them by a series of nerve strands.

In all cases of megrim, chronic ovarian colic, imperfect secretion and lessened elimination of urine, and in cases in which there is a pasty, muddy complexion, it is well to carefully examine the ninth thoracic vertebra. Usually there is an anterior condition or a marked separation of the spinous processes of the ninth and tenth. In patients suffering from a cystic degeneration of the ovaries, invariably lesions were found in this region in the cases that have come under the writer's observation.

The lesion either affects the nerve centers in the spinal cord by compressing the spinal vessels, or else it breaks the line of communication between the spinal segment and the viscus. The effects on the spinal cord and spinal column are similar to those of lesions of other thoracic vertebræ.

THE TENTH THORACIC.

The **tenth dorsal vertebra** is classed with the peculiar vertebræ because it has an entire costal facet at its upper border and no lower demi-facet. It approaches the lumbar type of vertebræ in that all the facets are larger and the spinous process shorter and more nearly horizontal. The **movements** of its articulations are more marked than those above, possibly on account of the character of the ribs articulating with it. Its lesions are similar to those above and result from similar causes. The anterior and twisted conditions are most common. The lesion causes

many and varied symptoms. It may have a sensory, motor, vaso-motor, secretory or trophic effect on viscera. It may cause pressure on adjacent structures such as the connective tissue or spinal cord.

A lesion of the tenth dorsal will produce a sensory disturbance in the **small intestines.** This disturbance may be hyperesthesia, paresthesia or anesthesia. Hyperesthesia occurs in enteritis and colicky conditions which ordinarily come from congestion of the intestinal mucus membrane. This hyperesthesia is conducive to increased secretion and excessive peristalsis, hence in typical cases, diarrhea, as in typhoid fever. The seat of the irritation may be in the mucous membrane but in many cases the cause lies in the spinal cord, the nerve roots and trunks, or in the spinal column. The **gastric crisis** is a well known effect of locomotor ataxia. The **intestinal colic** of a baby is another example of effect on intestines of a lesion in the spinal cord.

The thermic influences cause contracture of the spinal muscles, which in turn affect the spinal cord and its nerves, especially the nerves to the stomach and small intestines. The colic is not entirely due to the stimulation of the sensory nerves by the lesion, whether bony or muscular, but in part is due to the peristaltic cramping of the bowel. The explanation of the cause (a lesion of the tenth dorsal) and effect (pain in small intestines) lies either in the fact that the **sensory** impulses from the small intestines pass over the superior mesenteric plexus, the lower part of the solar plexus which receives the lesser splanchnic nerve, the white ramus, tenth thoracic nerve, posterior root, thence by way of the spinal cord to the medulla and sensorium, or in the fact, that the motor innervation of the intestine is by the same route and that the filaments are also in relation with the foramina of the tenth. Since both kinds of impulses pass through these foramina, any lesion of the tenth thoracic, will thus interfere, in some way, with these nerve filaments and consequently, sensory disturbances follow.

A lesion of the vertebra may irritate the sensory nerves in relation thus setting up impulses that would be **referred** to the small intestine or tenth dorsal nerve, their supposed source. Inhibition at the tenth dorsal, may stop the passing of impulses to the sensorium, hence relief would follow. Extreme extension of the spine with fulcrum or fixed point at the eleventh dorsal, is the best way in which to apply this treatment. The subluxated vertebra may interfere with a part of the impulses, hence a perverted sensation. Again, this lesion may entirely

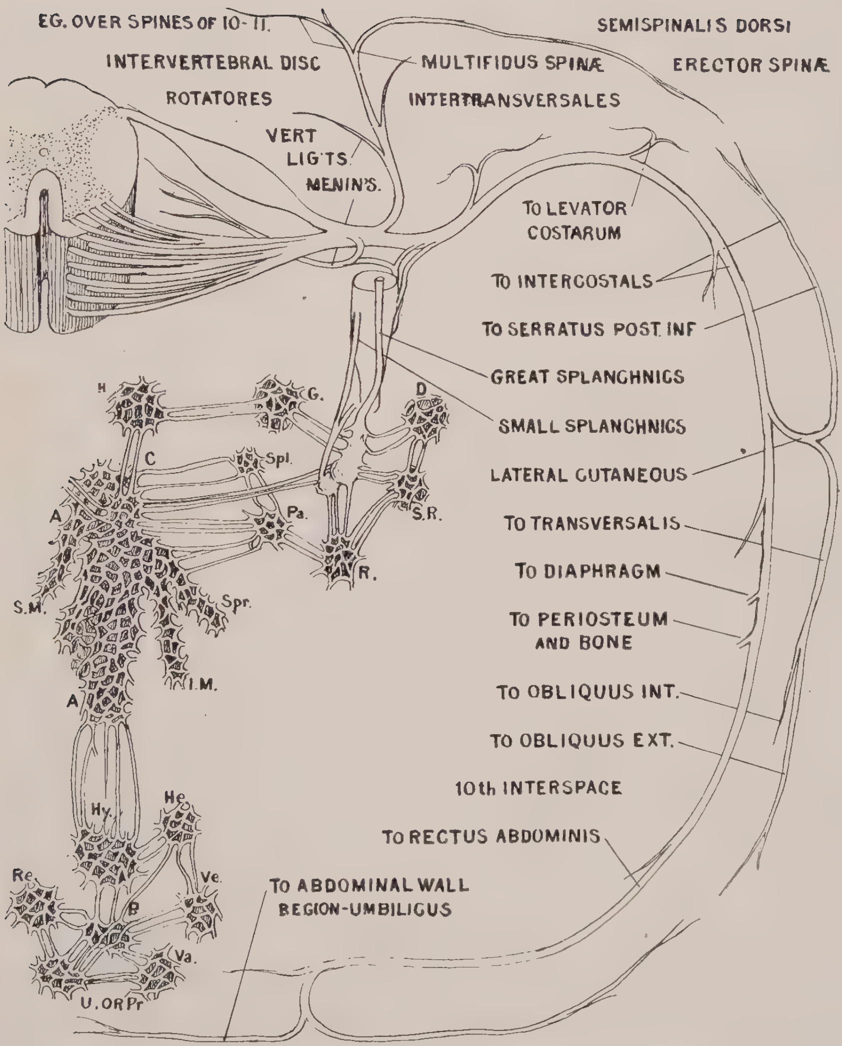

FIG. 54.—Showing the tenth thoracic segment of the spinal cord with its nerves and their distribution.

cut off the sensory line of communication, hence sensory paralysis of the small intestines. **Peristalsis of the small intestines, depends to a very marked extent on normal activity of the sensory nerves supplying them.** Normally the presence of food in the small intestine stimulates the sensory nerves, thereby setting up impulses that are carried to the spinal cord which, in turn, transfers them to the efferent nerves, thereby causing peristalsis of the small intestine, in other words it is a reflex process. A lesion of the tenth dorsal will interfere with this process, hence lessened peristalsis. From this comes indigestion and constipation.

According to Head, the **liver** and **gall-bladder** are supplied with sensation, in part, by the tenth dorsal nerve. The explanation is that the lesser splanchnic nerve carries impulses to and from the cœliac plexus which innervates the liver and gall-bladder by way of the hepatic, which is a branch or division of the celiac. The effects of such a disturbance have been considered above.

Pain in the **kidney** may result from a lesion of the tenth dorsal, since the lesser splanchnic nerve, which conveys the sensory impulses from it, is involved by a subluxation of this vertebra. An irritation of this nerve then, would produce pain that would be referred to the kidney. Pain in the **ureter** also comes from this lesion and is explained in a similar way. Such pain is called renal colic and most frequently comes from the passing of gravel. In some cases it comes from a lesion of the lower thoracic vertebræ and the effect is often quite marked, in fact I have seen cases in which the pain from such a lesion was as marked as from the passing of an ordinary calculus. Inhibition at the tenth dorsal in such cases, will cause dilatation of the ureter because it lessens the pain, hence lessens the reflex muscular contractions, or else the inhibition directly lessens the amount of motor impulses passing to the ureter. Inhibition at this point breaks the circuit or stops or lessens the number and intensity of the sensory impulses, hence the sensorium is not aware of the real condition.

According to Head, the tenth dorsal nerve contains sensory fibers for the **prostate** gland. Clinically, this seems to be the exception, the sensory centers being lower in the spinal cord. Accepting the statement as being true, the possible route would be the lesser splanchnics, spermatic plexus and prostatic plexus.

The **testicle** is supplied with sensation in part by the tenth dorsal

nerve, that is nerve filaments having their origin in the cells of the tenth dorsal ganglion pass directly to the testicle by way of the lesser splanchnic, renal plexus and spermatic plexus which are afferent as well as efferent in function. If these nerves are stimulated by the lesion, pain will be referred to the testicle. In pain or aching of the testicle, inhibition at the tenth dorsal may relieve since the impulses pass by way of the tenth thoracic segment on their way to the sensorium. **Anesthesia** or a loss of sensibility is more common and follows a paralytic lesion of the tenth dorsal, that is one that entirely obstructs the passing of sensory impulses beyond the point of obstruction.

In the female the analagous organ, the **ovary,** is affected in a similar way. It is not uncommon for a lesion of the lower dorsal vertebræ to produce **ovarian colic.** Contractures of muscles in relation with the tenth dorsal will also produce the ovarian cramp. The explanation is that the lesion affects, that is irritates the sensory nerves leading from the ovary to the spinal cord, that is the lesser splanchnic, which contains these sensory filaments. The point of irritation is usually in the common nerve trunk which is in relation with the intervertebral foramen.

The **fundus** of the uterus is also supplied with sensation by the ovarian plexus, hence some sensory disturbance would follow injury to this plexus. If the nerves were irritated by the lesion, there would be pain in the fundus which would be fairly constant but made worse by increased peristalsis. The effects of this disturbance would be painful menstruation. If the sensory impulses were inhibited, difficult menstruation and parturition would follow since each is a reflex process. These will be discussed later on.

The **pancreas** would be involved through its sensory nerve supply, this probably coming from the cœliac plexus. Deaver says that the lesser splanchnic goes directly to this plexus, hence the explanation of the sensory effects, is made easy.

A lesion of the tenth dorsal will produce a **cutaneous sensory effect** in the integument supplied by the tenth dorsal nerve through its anterior and posterior divisions. There may be hyperesthesia, perversion of sensation or anesthesia. In most cases the pain from this lesion is referred to a point external to and below the umbilicus. Disturbances of the viscera and structures innervated by the tenth dorsal segment, are often characterized by pain in the tenth intercostal nerve. This is especially true of intestinal, kidney, ureter, ovarian and some uterine diseases.

The **peritoneum** in relation with the tenth nerve, the tenth rib and its **periosteum,** the fascia and muscles in relation, are supplied with sensation by the tenth dorsal ganglion, consequently would be affected in some way by the lesion. Backache in this region is the result of contracture of the muscles in relation, this producing irritation of the sensory nerve supplying the muscles.

A lesion of the tenth dorsal vertebra will produce a **motor effect** in the viscera and organs mentioned under the above head since nearly if not all nerves are mixed nerves. A lesion affecting one part of the nerve will in all likelihood, affect other parts; that is, if the sensory filaments are involved, the motor filaments will also be affected. The peristalsis of the **small intestines** may be lessened or increased by a lesion of the tenth dorsal since it may inhibit or stimulate the motor supply. The **gall-bladder** and **bile** ducts are affected by this lesion, but possibly not so readily as by a lesion a little higher in the cord, The **ureter** is also affected through its motor supply, there being a disturbance of peristalsis. In a similar way the motor supply of the testes and ovaries, prostate gland and uterus may be altered in some way by the lesion since the impulses pass over the lesser splanchnic, which nerve is nearly always affected by an ordinary lesion. The spleen is similarly involved, that is, its movements or rhythm are interfered with by the lesion.

The **muscles** innervated by the tenth dorsal segment are affected by a lesion of the articulations of the tenth dorsal vertebra. The effect on the muscles may be one of relaxation or contracture. If the lesion is an irritative one, contracture will follow, if paralytic, relaxation will result. The muscles involved directly by a lesion of the tenth dorsal are the intercostales, levatores costarum, serratus posticus inferior, obliqui, transversales and recti abdominales, erector, multifidus and rotatores spinæ and the diaphragm. The effects of relaxation and contracture of these muscles have been considered above.

A lesion of the tenth dorsal will produce a **vaso-motor** effect on vessels innervated by the nerves that are in relation with the vertebra. The blood-vessels involved are the **tenth intercostal** and its branches, **renal, ovarian,** and **spermatic, celiac axis** with its branches, the **splenic, gastric** and **hepatic, superior mesenteric** and the **vena azygi veins.** The effect is either one of constriction or of dilatation. In most instances dilatation takes place, or at least is the chronic effect of the lesion, on the vessel. If the intercostal vessels are dilated, the circulation through the

muscles of the back, abdominal wall, parietal layer of the peritoneum and, most important of all, the circulation of the tenth dorsal segment is impaired. The last leads to passive congestion of the cord with malnutrition of the nerve cells of this segment. As a result, it is possible for every nerve derived from this segment to become diseased. The effect on the visceral nerves seems to be most marked in those that supply the small intestine and ovary.

In cases of disturbances of activity of the ovary, kidney and small intestine, the trouble may be in the spinal center, its nutrition being involved by the lesion causing dilatation of the blood-vessels. Congestion of the spinal cord, if passive, in such cases, tends to lessen activity of the nerve cells in the segment involved.

The **renal** vessels are involved because the lesser splanchnic nerve is affected by the lesion, and this nerve carries vaso-motor impulses to the vessels of the kidney. Inhibition will at first produce an increased secretion of urine on account of the congestion, but later on lessened secretion results. Stimulation of the vaso-motor nerve will lessen the size of the renal vessels hence will lessen secretion. Most diseases of the kidney are of vaso-motor origin, that is the vessels are dilated and the circulation lessened in rapidity, hence a lowering of the vitality of the blood and of the part, in proportion to the degree of dilatation of the vessels and slowing of the blood-stream.

The **ovarian** blood-vessels are very often affected by a lesion of the tenth dorsal. If the vaso-motor impulses are inhibited, congestion of the ovary follows. Congestion of the ovary is attended by dysmenorrhea, disturbed ovulation, pain in the iliac fossa on the same side, backache, sense of weight, and finally leads to inflammation. Mammary disorders, as well as disturbances of the sexual function, follow or accompany the congestion. A constriction of the ovarian blood-vessels causes anemia of the ovary which, if kept up for any great length of time, causes atrophy with softening. The **infantile ovary** results most frequently from an injury to the spine from the ninth to the twelfth dorsal, which affects the ovary through the vaso-motor nerves; that is, the development is arrested or else the nourishment is disturbed. The lesion of the tenth dorsal, produces these effects by producing pressure, either on the filaments that go to form the lesser splanchnic nerve, or on the blood-vessels that nourish the tenth dorsal segment.

In the male analogous conditions may arise; that is congestion and

anemia of the testicle. The most common and important effect on the testicle is varicocele. In this disease the vaso-motor nerves are inhibited by the lesion, and as a result, the spermatic veins dilate. If this condition remains for a while it is called varicocele. There are other causes of dilatation of these veins which are important and classed as exciting ones and probably the most potent cause of all is repeated, ungratified sexual desire.

The **superior mesenteric** vessels are quite frequently affected by a lesion of the tenth dorsal, judging from the effects in the parts supplied by this artery in cases in which there is present this lesion. If the lesion inhibits the nerves to these blood-vessels, congestion takes place with altered and increased secretion. Catarrh of the intestine is a common type. Intestinal indigestion is a sequel. Typhoid fever is another disease which has for a predisposing cause congestion of the intestine, from lesions inhibiting the vaso-motor as well as other nerves supplying the bowel. If the lesion stimulates the vaso-motor nerves, anemia of the bowel results but this is only a temporary effect since prolonged stimulation leads to inhibition. In anemia, the secretions are lessened and peristalsis impaired.

The **pancreatic** blood-vessels are affected in a similar way; that is, they are dilated when the lesion inhibits, and lessened in size when the lesion is irritative. Dilatation causes increased secretion at least for a while; after it becomes chronic, the quality of the blood may be so impaired that secretion is altered or lessened.

The **splenic, hepatic** and **gastric** vessels may be affected since the lesser splanchnic nerve passes into the celiac plexus and this plexus supplies the above named vessels. The lesser splanchnic as stated above, is affected by the lesion of the tenth dorsal, and this nerve conveys vaso-motor impulses to the celiac plexus.

The azygi veins are supplied in this region by branches from the solar plexus. The lesser splanchnic nerves in all probability, carry impulses to the parts of the veins in relation with this segment.

A lesion of the tenth dorsal will have a **secretory** effect on organs that secrete and are supplied by the lesser splanchnic nerve. The most important organs affected are the small intestines, testes, ovaries, kidneys, pancreas, supra-renal capsules and probably the liver, spleen and stomach. Secretion does not depend entirely on the vaso-motor nerves but in part (I do not know how much) on the so-called secretory

nerves. Stimulation of these secretory nerves increases the amount of secretion; inhibition lessens it. The **lesser splanchnic** is supposed to have in it secretory filaments. Lesions stimulate or inhibit.

A lesion of the tenth dorsal may stimulate or inhibit the **tenth dorsal** nerve. The tenth dorsal nerve supplies the integument in relation with secretory impulses to the sweat and sebaceous glands, hence disturbance of these glands in lesions of the tenth dorsal.

All nerves are more or less **trophic** in character. A lesion of the tenth dorsal will produce trophic effects in parts supplied by the nerves having their origin in the tenth dorsal segment. The effect is most marked in the muscles of the back. At first marked contracture takes place; later on, atrophy, as is evidenced by the widening of the median furrow of the spine.

The **adjacent tissues** and structures are also affected by the lesion. We would mention in particular the spinal ligaments, fascia and spinal cord. The effect may come from traction or pressure on the tissues in relation. The effect varies with tissues involved and the amount of traction or pressure. Pressure on the spinal cord produces myelitis.

Summary. A lesion of the tenth dorsal will affect the lesser splanchnic and the tenth dorsal nerves. The splanchnic conveys sensory, motor, vaso-motor, secretory and trophic impulses to the kidney, ureter, ovaries and testes, fundus of uterus and prostate gland, stomach, liver, spleen and pancreas. The cerebro-spinal nerves supply the integument, muscles and fascia. Almost any disease of the above mentioned parts, follows a lesion of the articulations of the tenth, since the lesion interferes with the nerves, blood-vessels, spinal cord and all tissues in relation.

THE ELEVENTH THORACIC.

The **eleventh dorsal** vertebra is also classed as one of the peculiar vertebræ. Morris says: "The eleventh has a large body resembling a lumbar vertebra. The rib facets are on the pedicles and they are complete and of large size The transverse processes are short, show evidence of becoming broken up into three parts, and have no facets for the tubercles of the eleventh pair of ribs. In many mammals the spines of the anterior vertebræ are directed backward and those of the posterior directed forward, while in the center of the column there is one spine vertical. The latter is called the anti-clinial vertebra and indicates the point at which the thoracic begin to assume the character of

lumbar vertebræ. In man the eleventh thoracic is the anti-clinal vertebra."

The **mobility** of its articulations is quite marked since the ribs do not articulate with the transverse processes. The intervertebral discs are thicker and possibly more elastic, judging from the increased mobility. The vertebra is often subluxated, due, I believe, to its position, it being located at the junction of a movable portion, the lumbar vertebræ, with a comparatively immovable portion, the thoracic vertebræ. It is subject to lesions similar in degree and character to those mentioned above, the approximation or separation being very common, if not the most frequent. If this vertebra alone is involved, the subluxation most frequent is an anterior rotation of the vertebra, affecting the articulations above and below.

The **integument** supplied by the eleventh dorsal nerve is affected by a lesion of the eleventh dorsal, because of impairment of the nerve supply. This nerve is supposed to carry **sweat** impulses to the integument of the eleventh interspace and to that in the lower thoracic and upper lumbar regions. Stimulation of the nerve usually increases the amount of sweat since its secretion is determined by secretory rather than vaso-motor nerves. Localized sweating in the lower thoracic region is not uncommon and is suggestive of a nervous condition or bowel disorder such as constipation. Lessened secretion of sweat results if the sweat centers are made less active by the lesion or if the eleventh thoracic is inhibited, thereby impairing the passing of secretory impulses to the skin. This condition is spoken of by Landois who says: "It has been observed in circumscribed areas of the skin as one of the phenomena of certain tropho-neuroses as, for instance, unilateral atrophy of the face, and in paralyzed parts. In some of these cases there may be paralysis of the nerves in question or of their spinal centers."

The **trophic** condition of the skin is controlled to a great extent, by nerves called the trophic nerves. In case of the spinal nerves the trophic nerve is only a part of it, not a separate distinct nerve trunk, but composed of filaments enclosed in a common sheath. Church says: "The significance of abnormal variations in the nutritional conditions of a part is at once apparent when it is recalled that the growth and nourishment of all the structures of the body are presided over by trophic centers acting through peripheral nerves."

For the proper nutrition of skin, muscle, nerve and bone, the integrity of the trophic center, of its peripheral nerves, and their terminals,

is essential. In other words, the anterior spinal cell and its polar prolongation in the efferent nerve, the lower neuron, can not be injured or destroyed without correspondingly impairing the function of nutrition in its area of distribution. Lesions of the vertebra affect both the trophic center and its peripheral path, thus dystrophies of the skin fol-

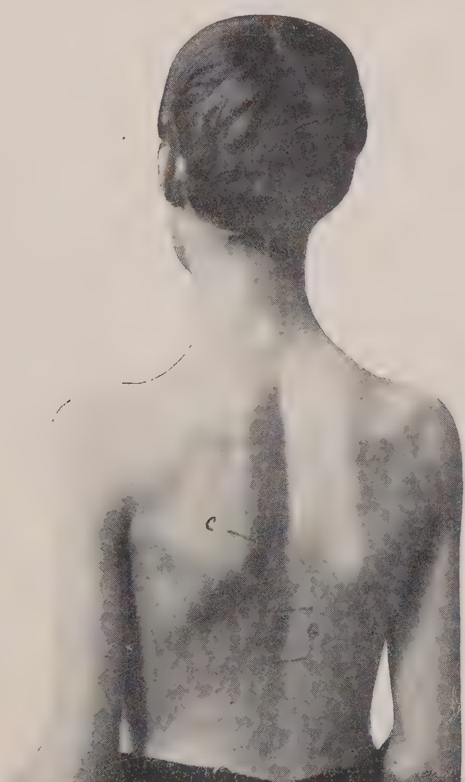

FIG. 55.—Showing an anterior condition of the 10th and 11th thoracic vertebræ, b; c. muscular contracture. The patient had some kidney disorder. (From photo)

low. These lesions affect the trophic center through its nutrition and the peripheral path by pressure on the nerve, usually at its exit from the spinal canal.

A lesion of the eleventh dorsal will affect a localized portion of the

skin principally on account of effect on the peripheral tract, the eleventh thoracic nerve and its branches. These trophic disturbances are characterized by a thickened, dry, scaly epidermis and in some cases a glossy condition. In other cases, pimples or even boils develop. The lesion may so affect the superficial nerves that an inflammation or neuritis may develop, herpes zoster being an example. In milder cases the lesion produces a superficial or cutaneous tenderness. In many of these cases there are no inflammatory indications but the slightest touch produces intense pain. In such cases the lesion affects the spinal cord, its meninges, or in some cases, the trunk of the spinal nerve. In other cases the lesion affects the viscera supplied by the eleventh dorsal segment, and if irritative, the pain is referred to the cerebro-spinal nerves and is felt in the integument of superficial tissues. Inflammatory disturbances of the ovary, small intestine, vermiform appendix, ureter, cecum and the peritoneum in relation with these structures, will cause pain to be referred to the areas innervated by the eleventh thoracic spinal nerves.

The **muscles** of the back and abdomen, the intercostals and the diaphragm will be affected by a lesion of the eleventh dorsal. In the case of the spinal and abdominal muscles, they will be contractured or relaxed; contractured if the lesion is irritative, relaxed if inhibitory. The intercostal muscles also, in all likelihood, become contractured but they are so flat and short that the condition can not be readily detected. Contractured conditions of the spinal muscles produce (1) **backache**, (2) **vascular disturbances of the spinal cord** and (3) **curvature of the spine.** Relaxation of these muscles produces weakness of the spinal column. Relaxation of the abdominal muscles produces enteroptosis. If the diaphragm is affected, and it frequently is, respiration is disturbed, usually becoming difficult.

The **peritoneum** is affected by a lesion of the eleventh dorsal. Its secretion is disturbed, usually lessened. If increased, ascites develops; if lessened, pain on movement of parts. In some, the lesion produces a pain that is referred to the abdominal wall and peritoneum. Peritonitis develops if the lesion is irritative, since the blood-vessels of the peritoneum would be affected by the lesion. Relaxation of the visceral layer of the peritoneum followed by enteroptosis, occurs in paralytic lesions.

The **ligaments** of the ribs and vertebra are affected by a lesion of

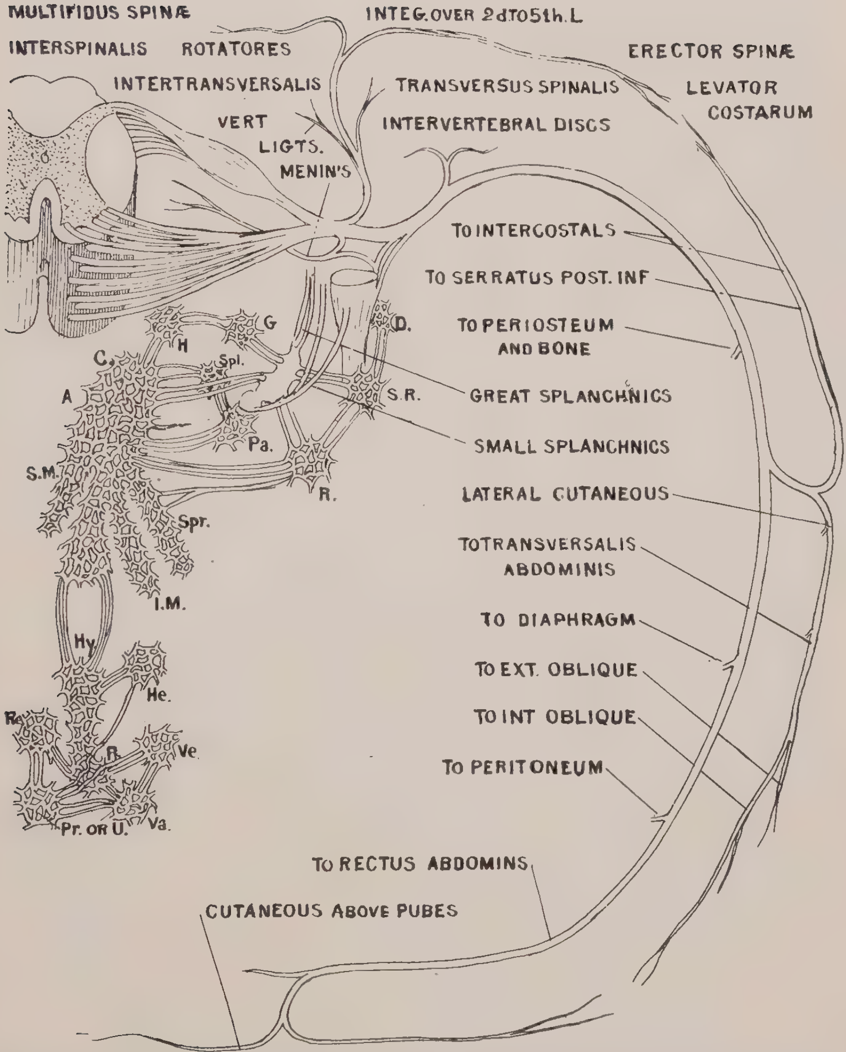

FIG. 56.—The eleventh thoracic segment of the spinal cord, with its branches and their distribution.

the eleventh dorsal, because their innervation is disturbed. This is also true of the periosteum. The ligaments of the vertebra are either stretched or broken by the lesion. At any rate they always thicken and probably **always partly fill the intervertebral foramina.** In acute cases the ligaments become very tender and remain so for quite a while if not properly treated. The vertebral joints are sprained in a way similar to that of other joints and the effects are also very similar.

The **spinal cord** is affected by the lesion either directly, as by pressure, or indirectly through impairment of its circulation. Pressure on the spinal cord at this point would produce paraplegia and loss of control of the various centers at points lower down in the cord. If pressure produces complete transverse myelitis, atonic paraplegia follows; but if not complete, spastic paraplegia results. Interference with the circulation to the cord of course produces various effects which depend on cells affected, amount and degree of disturbance and length of standing of lesion. The spinal cord is also affected by ascending degeneration from injury of or pressure on, the posterior nerve roots. These ganglia are in the foramina and a very slight deviation of the vertebra would produce pressure on them, this producing degeneration. The effect seems to be a sensory one, there being a loss, to a certain degree, of tactile sensation.

The **spinal column** is weakened by a subluxation of any of its vertebræ. A lesion of the eleventh dorsal, causes a weakness of the small of the back and the patient is unable to undergo much exercise without marked discomfort in this area. Spinal curvatures often start from a subluxation of the eleventh dorsal, in fact, I doubt that pathological curvatures start from any other cause than a subluxation of a vertebra. **Lumbago,** often results from a lesion of the eleventh dorsal, but most often results from a lesion lower in the spinal column. The explanation is that the movement of the spinal articulations is lost or markedly lessened on account of the subluxation of the vertebra or a sprain of its ligaments.

The **viscera** most commonly affected by this lesion are the **small intestines, cecum** and **vermiform appendix, ovary** and **testicle, kidney, spleen, ureter, prostate, uterus, epididymus, Fallopian tubes,** and **suprarenal capsule.**

The **small intestines** are affected because their nerve and blood supply are disturbed by the lesion. The lesser splanchnic carries sensory,

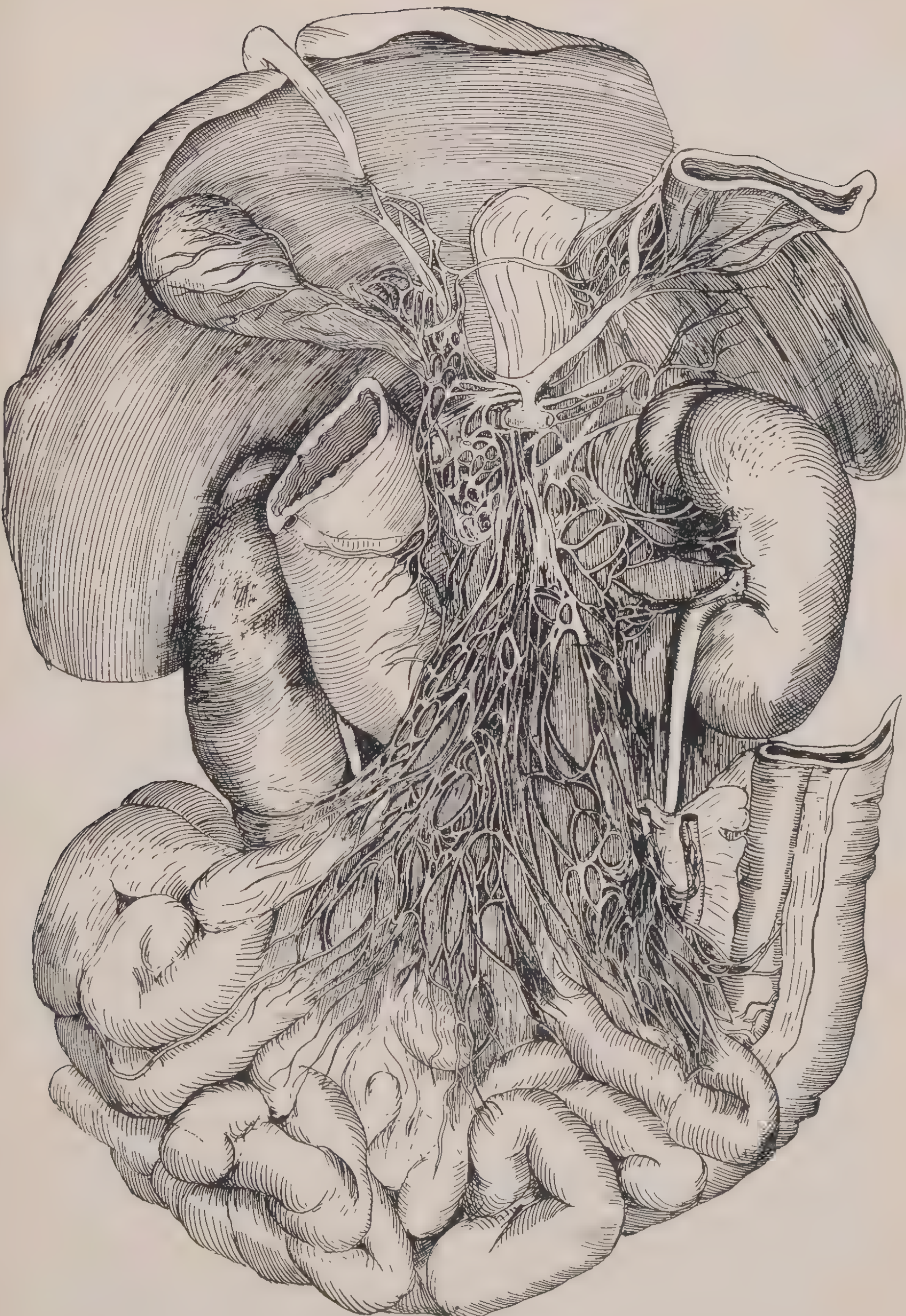

Fig. 57.—Showing the nerve supply of the abdominal viscera. The liver has been drawn back, exposing the gall-bladder. Enteroptosis produces a stretching of these nerves.

motor, secretory, vaso-motor and possibly trophic fibers to the small intestines. This nerve is affected because the filaments composing it are subject to compression by the subluxated vertebra while they are in the intervertebral foramen.

Howell in speaking of the function of the sympathetic innervation of the small intestine says: "The fibers received from the sympathetic chain give mainly an inhibitory effect when stimulated, although some motor fibers apparently may take this path. Bechterew and Mislawski state that the sympathetic fibers for the small intestine emerge from the spinal cord as medullated fibers in the sixth dorsal to the first lumbar spinal nerves, (or lower-bunch) and pass to the sympathetic chain in the splanchnic nerves and thence to the semilunar plexus."

Clinically, it seems that these impulses to the small intestine pass to it by way of the ninth, tenth and eleventh spinal nerves, that is, these segments have more to do with the innervation of the small intestine than any other. This has been determined, to a great extent, by observing the effects of lesions is this region on the intestine; it being found that a lesion affecting this part disturbs the intestine most.

From this lesion there would result pain, as in enteralgia; disturbed peristalsis, as in diarrhea; constipation and invagination; increased or lessened secretion, as in catarrhal enteritis and constipation; congestion, as in enteritis and ulceration.

Enteralgia can be relieved by inhibition at the eleventh dorsal spine, It can be cured in most instances, by correction of lesion of the tenth or eleventh dorsal vertebra.

The **cecum** is affected through disturbances of its blood and nerve supply. Its nerve supply is from the superior mesenteric plexus which is derived from the lower part of the solar plexus into which part, the lesser splanchnic nerve enters. This nerve controls the blood-vessels supplying the cecum, also its sensory, motor, secretory and trophic impulses. The cecum marks the junction of the large and small intestines. It is quite large and has leading from it the vermiform appendix. Its function is similar to that of the rest of the large bowel, that is, to serve as a sort of reservoir in which desiccation of the fecal matter may take place. A lesion of the eleventh dorsal will, through the nerve supply, alter and affect its peristalsis, secretion, sensation and amount of blood. **Constipation with impaction** of the cecum is the result. From this develops a change of position from the increased weight, that is the cecum

prolapses. This causes congestion and stagnation of the blood and is the starting point of many abdominal disorders. The impaction soon weakens or paralyzes the valve closing the lumen of the appendix so that it can neither prevent the passing of particles of fecal matter into the appendix, nor expel them after they enter. The contents of the appendix then undergo fermentation, possibly putrefaction, and soon the patient has appendicitis. The lesion of the eleventh dorsal vertebra is the predisposing cause, the particles of partly digested food, the exciting cause. The lesion inhibits the passing of sensory, motor and sectory impulses, hence a deadened condition of the bowel results. These nerve impulses arise in the spinal cord and reach the cecum by way of the ventral root, common trunk, anterior division, white ramus, sympathetic ganglion, lesser splanchnic, solar plexus (lower portion) and superior mesenteric plexus. If the lesion is **irritative,** there may be excessive peristalsis, hence **flux,** or diarrhea in mild cases. Invagination may result and the small intestine be partly drawn into the cecum.

Inflammatory conditions occur if the vaso-motor nerves are inhibited to such a degree that the blood-vessels remain engorged. In **typhoid fever,** the predisposing cause is a lesion in the lower thoracic area, which weakens the part, principally through the trophic and vaso-motor disturbances, after which the bacillus, the exciting and immediate causes the more readily attacks the part. The lesion is often at the articulations of the eleventh dorsal, affecting the lesser splanchnic, which carries trophic and vaso-motor impulses to Peyer's patches of the small intestines. The trouble may at first be a secretory or motor one; that is, there is lessened peristalsis and finally constipation. A lessened secretion of succus entericus is responsible for many cases of constipation. Constipation is indicative of a lowering of the vitality of the parts, which is mainly responsible for the fever. If the intestines are normal, the ingestion of food or water in which there are typhoid bacilli will have no deleterious effect, but if the vitality of the parts is lowered by a lesion which interferes with the passing of trophic, vaso-motor, motor or secretory impulses, the microbe peculiar to typhoid fever will find a favorable nidus for propagation, and typhoid fever will result.

The **kidneys** are affected by this lesion because the lesser splanchnic nerve conveys the various nerve impulses from the spinal cord to the kidney. As explained above, this nerve, either the trunk or the filaments forming it, is in relation with the articulations of the vertebra and

the slightest deviation of the vertebra will produce pressure on it. The **ureter** is affected for the same reason.

According to Head, the eleventh dorsal has to do with the sensory innervation of the bladder, as in "overdistension and ineffectual contraction." The nerve pathway must be the lesser splanchnic and the aortic plexus.

The **prostate gland** is also affected by this lesion; since the nerve impulses reach it in a way similar to those of the bladder. The lesion interferes with it in some way, hence the effects.

The **testes** and **epididymus** are also involved by this lesion. The impulses controlling them are carried by the lesser splanchnic to the renal, thence over the spermatic. The nutrition, amount of blood, sensation and motion are controlled by this nerve, hence almost any pathological condition of these parts may result from the lesion. A poorly developed or badly nourished small, tender, soft testicle is the most common effect. **Varicocele** is also common. **Sterility** is not an unusual effect.

The **ovaries** are affected in a similar way; also the fundus of the uterus and the Fallopian tubes through their nerve supply, the ovarian plexus. Motor, sensory, vaso-motor, secretory or trophic effects result from the lesion, hence imperfect or too marked contraction, painful contraction, congestion, leucorrhea or softening of the uterus, especially the fundus, may result. These effects on the uterus have been noted clinically.

Lesions of the eleventh dorsal are most commonly associated with kidney, ovarian and intestinal disorders. These disorders are best represented by albuminuria, ovarian inflammation, and intestinal indigestion and constipation.

THE TWELFTH THORACIC.

The **twelfth dorsal vertebra** is a transitional vertebra, marking the change from the thoracic to the lumbar type. In appearance, it very much resembles the lumbar vertebræ in that all the parts are large, the spinous process short, thick and almost horizontal. The superior facets face almost directly back while the inferior, instead of looking forward, are turned outward to articulate with the superior facets of the first lumbar which face inward. As is the case with the eleventh dorsal, the ribs do not articulate with the transverse processes, hence the mobility of both the vertebræ and ribs is greater on this account.

The **transverse process** is rudimentary and is usually divided into three parts. There is a single facet on the body for articulation with the head of the twelfth rib, hence the vertebra is different from those above. The **mobility** of the articulation between the twelfth dorsal and first lumbar is quite marked in the normal subject but this articulation is often the seat of hypermobility. A "break" is the most common form of lesion. By this term is meant a separation of the spinous processes. It is sometimes pathological but in most cases is not. It occurs oftenest

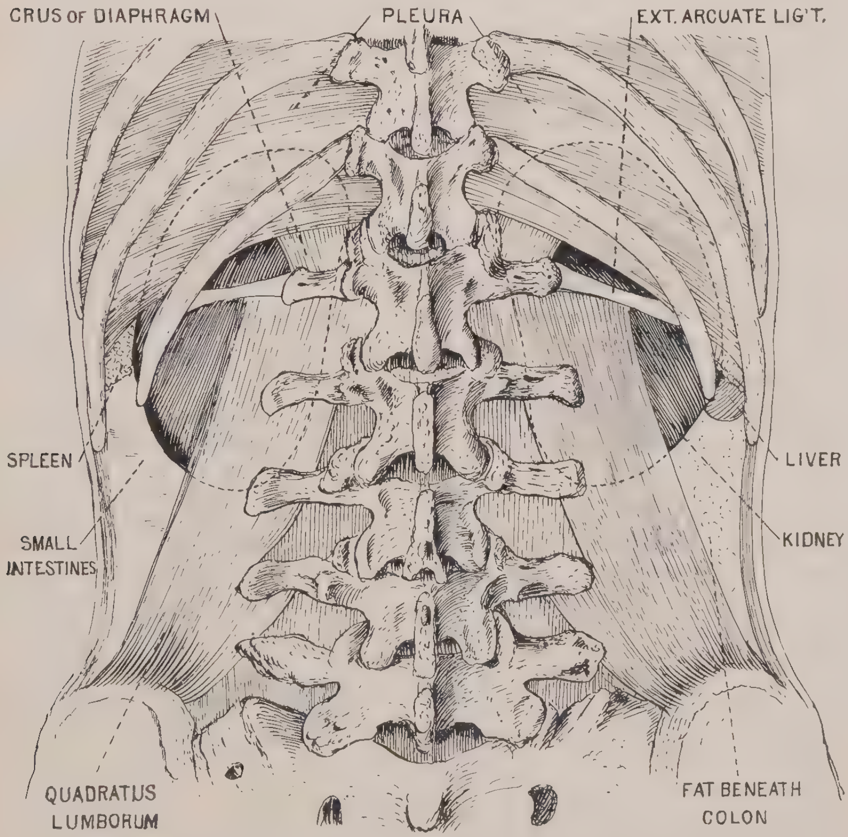

FIG. 58.—Showing the relation of the kidneys to the ribs and quadratus lumborum muscles. Pressure immediately below the twelfth rib near the vertebral end is productive of pain in most disorders of the kidney or pelvic organs.

at this articulation on account of the change in character of the vertebræ and because this part of the spine bears the greatest part of the strain in lifting. The mobility, which is normally quite marked, is also in part, responsible for the separation. Unless there is approximation of the vertebræ above or below, the break causes little trouble other than weakness of the spine since the foramina are increased rather than decreased in size on account of the stretching of the ligaments. In many subjects the separation and hypermobility are only compensatory and in such cases it is a mistake to attempt reduction of the supposed subluxation.

The articulations of the twelfth dorsal are subject to the usual vertebral lesions such as would result from rotation, approximation, anterior and posterior deviations of the vertebræ in relation. The **effects** vary with the degree of the lesion, length of standing, that is the extent to which nature has overcome the disturbance, the structures pressed on and also their condition. In addition, the degree of the effect is measured in part, by the condition of the viscus or other structures depending on the twelfth dorsal segment for nutrition and nerve supply. For example, **if the function of the testicle were abused, a very trivial lesion, one that would ordinarily have no effect, would at once affect the function of the organ, disturbing it the more.**

The **effects** of a lesion of the articulations of the twelfth dorsal vertebra may then be classified under five heads: **sensory, motor, vasomotor, secretory** and **trophic.**

The **sensory** effects may be conveniently divided into effect on the integument, on viscera and on other structures. The **integument** depending on the nerves in relation with the twelfth thoracic vertebra for sensation, is that over the crest of the ilium, the upper part of the gluteal region and as low as the trochanter, over the pubes and a part of the tip of the penis. It is rather odd that few, if any, sensory branches supplying the integument in the middle and upper lumbar regions come from the lumbar nerves, but from the lower thoracic, principally the tenth and eleventh. These areas may be anesthetic or hyperesthetic from the above lesion or they may be reflexly affected, that is pain may be referred to the skin over this area from disease of viscera supplied by the same spinal segment as for instance, the ovary. If the subluxation or lesion inhibits the passing of the sensory impulses, anesthesia or numbness would result. In acute or recent subluxations, an irritation

exists producing pain in all or a part of the above described area. Conversely, pain in this area is indicative of a lesion of the twelfth dorsal, or rib on the same side. In some forms of female disorders, especially if the ovaries are involved, the patient often describes a pain as passing or running over the crest of the ilium. This is a referred pain. The explanation is that the sensory or afferent impulses arising from the diseased condition, are carried to the spinal cord, the twelfth dorsal segment, by way of the ovarian and renal plexuses, thence to the sensorium by the same tract that carries impulses from the integument. The sensorium mistakes the source of the impulses and wrongly refers them to the cutaneous nerve supplying the crest of the ilium, that is the twelfth dorsal or subcostal nerve.

The renal plexus is not entirely distributed to the kidney. A part forms the ovarian, or rather the impulses from the spinal and gangliated cord pass directly through the renal to the ovarian plexus and these nerves carrying the impulses have little, if anything, to do with the supply of the kidney. According to Head, the viscera supplied with sensation by the twelfth dorsal segment or rather the viscera whose sensory impulses pass through this segment on their way to the sensorium are the kidneys and ureter, intestines as low as the rectum, urinary bladder, prostate, testes and epididymus, uterus and its appendages. The impulses from the kidneys and ureter, pass to the cord by way of the least splanchnic. The intestines are supplied by the mesenteric plexuses which send to and receive impulses from, the lower dorsal and lumbar portions of the spinal cord. The genitalia connect with the spinal cord by way of the ovarian or spermatic, and uterine plexuses.

A lesion of the twelfth dorsal articulations may produce pain in the various organs and viscera mentioned above, but more commonly the pain is referred to the areas supplied with sensation by the twelfth dorsal nerve which is derived from the same source as is the sensory innervation of the viscera. The lesion more commonly inhibits the passing of impulses to the spinal cord, hence the parts will not readily respond to a stimulation or an irritation. On account of this, the peristalsis of the viscera supplied by the twelfth dorsal segment is seriously interfered with since sensation to a great degree controls peristalsis. In the case of the large bowel constipation follows. How common a condition it is for the abdomen of a patient to feel as if it were paralyzed, and we base our prognosis in many cases on the degree of weakness and relaxation.

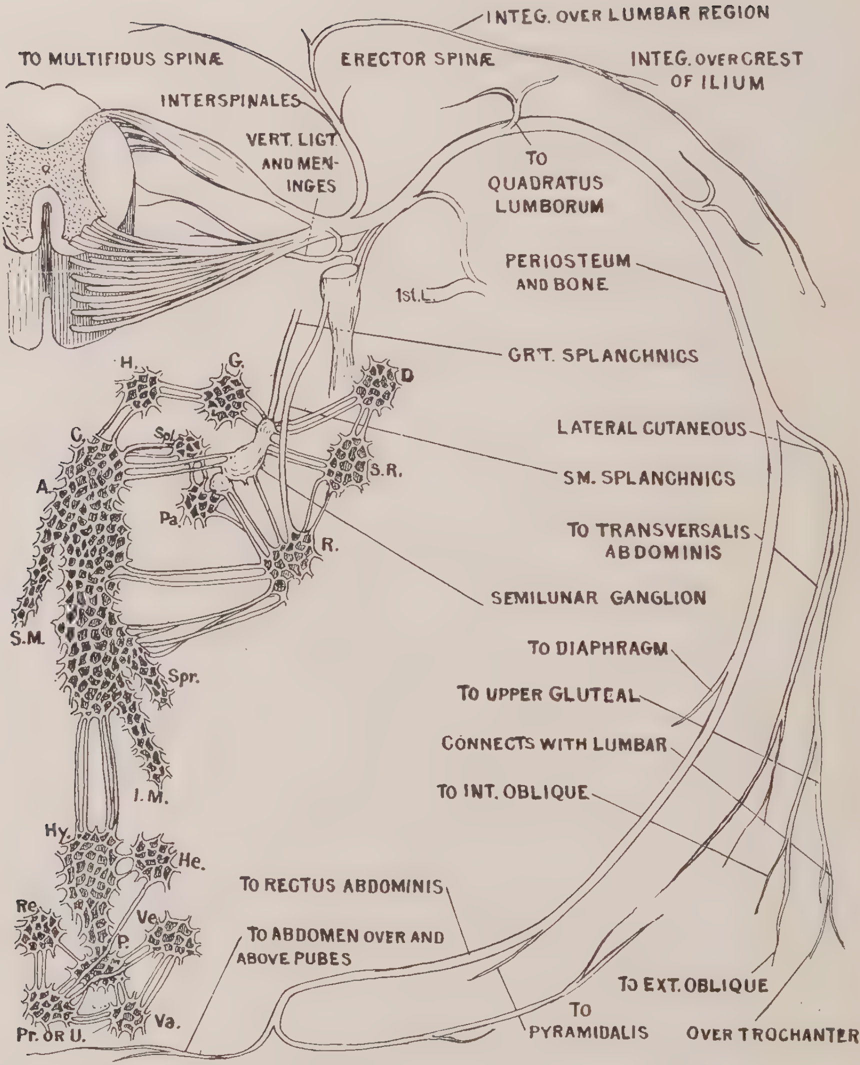

FIG. 59.—The twelfth segment of the thoracic spinal cord, with its nerves and their distribution.

If the **cecum** is involved, **appendicitis** results in many cases. As stated before, if the irritability of the appendix is lessened, the particles of fecal matter which get into the appendix fail to stimulate the sensory nerves supplying it, because these nerves are partly or completely paralyzed by the lesion. **Peristalsis of the appendix,** as well as that of the other parts of the intestinal tract, **is governed by the irritability of the mucous membrane lining it, that is peristalsis is, to a great extent, a reflex process.** The fecal matter stimulates the sensory nerves of the bowels. The impulses thus generated pass to the spinal cord and are there transferred to the efferent nerve cells and the result is, that motor impulses are sent to the bowel. Any lesion breaking or crippling this reflex arc, will lessen peristalsis of the bowel. Anything stimulating any of the parts forming this arc will, in all likelihood, increase the peristalsis.

A lesion of the twelfth dorsal vertebra will impair the passing of sensory impulses to the spinal cord, hence paralysis follows if the obstruction is complete, numbness, if partial. From this arises constipation, appendicitis and any other disease dependent on a lessened peristalsis.

Micturition is also a reflex process and the condition of the sensory nerves supplying the bladder is an important consideration. A lesion of the twelfth dorsal will affect the sensory innervation. It may stimulate it, causing frequent micturition, or it may deaden the sensibility, causing imperfect micturition or retention of urine. Although the center for micturition is a few segments lower in the spinal cord, according to Head the twelfth dorsal nerve controls the sensory innervation of the bladder. Clinically, it is found that micturition is often affected by a lesion of the twelfth dorsal.

The **testes** and **ovaries** are supplied with sensation by the spermatic and ovarian plexuses, hence would be involved by lesions affecting these nerves. Nearly all the internal genitalia receive impulses from as high in the spinal cord as the twelfth dorsal segment, and accordingly, would be involved.

The adjacent **muscles** and those forming the abdominal wall, also receive sensation from the twelfth dorsal. False or pseudo-appendicitis, is often due to a lesion of the articulations of the twelfth dorsal, this causing pain in the iliac fossa by affecting the eleventh and twelfth dorsal nerves.

The lesion at the twelfth dorsal will produce a **motor** effect on muscles, tissues and viscera. The muscles affected are those supplied by the

twelfth dorsal nerve; the abdominal and back muscles, the quadratus lumborum and in most instances, the diaphragm. These muscles may be contractured or relaxed. The effects on these muscles, of a lesion disturbing their innervation have been considered with the exception of that of the **quadratus lumborum.** This muscle, if relaxed, will permit of the drawing upwards of the twelfth rib, that is it becomes displaced upward under the eleventh rib. If the muscle is contractured it will draw the twelfth rib down. In replacing or setting the twelfth rib, the condition of this muscle must be considered, because it determines to a great extent, the position of the rib. Contracture of these muscles produces an ache in the region of the small of the back. This is because of the fatigue.

There may be a motor effect on the small and large intestines, kidney and ureter and the internal genitalia. This is explained by the fact that the lesser and least splanchnic nerves carry impulses to the above named viscera and structures and these nerves, or the filaments going to form them, are always more or less affected by the lesion. These splanchnic nerves usually pass through plexuses but the nerve filaments that spring from the cells in the grey matter of the spinal cord eventually reach their destination, that is, the impulses originated in the cell, are carried directly to their destination. The lesion interrupts this connection or else stimulates the nerves, thereby increasing the amount and number of its impulses. According to Quain, the circular muscle fibers of the rectum are supplied by the lower thoracic segments. From this, rectal disorders may follow a lesion of the twelfth dorsal.

This lesion will, through the **vaso-motor** nerves, affect the **intercostal**, **renal, ovarian** and **spermatic, mesenteric** and **iliac** blood-vessels. The abdominal aorta, inferior vena cava and the agyzi veins are also affected by the lesion, through their nerve supply. The effects of constriction and dilatation on these blood-vessels have been considered above. Suffice it to say that congestion of the twelfth dorsal segment, the muscles of the back, the intestines, ovaries and testes and the kidneys are common effects. The diseases most frequently caused by these vaso-motor disturbances are hyperemia with hemorrhage in the spinal cord, catarrh of the bowels, inflammation of the ovary or testicle, varicocele and nephritis.

The **secretory** effects are most marked in the integument, intestines, kidneys, ovaries and testes. The first has been considered, there being

hyperidrosis or anidrosis. The **succus entericus** may be lessened or increased in amount. If markedly lessened, constipation results; if increased, diarrhea. These effects, or at least some variation of them, are fairly common. The explanation is that the lesion affects the lesser and least splanchnic nerves which carry secretory impulses to the intestines. Experimentally, stimulation of this nerve increases secretion in the intestines, inhibition lessens it. In this, the vaso-motor element must also be considered. The lesion at the twelfth dorsal articulation may do either, hence if the lesion is substituted for the electric or chemical agent ordinarily used, any standard work of physiology contains the explanation. Clinically, it is known that the lesion may be a paralytic or irritative one, hence the possibility of the substitution. This lesion may affect the secretion of urine through the renal splanchnic nerve.

The **ovaries** have an internal secretion which in all probability, is controlled by a secretory nerve, if it is like other glands. The secretion of the testicle is likewise under the control of a secretory nerve, although the amount and character of the blood enters largely into the process. The cells controlling these secretory impulses are located in the spinal cord, the twelfth dorsal segment containing some. They connect with the organs by way of the ovarian or spermatic plexus of nerves.

The **trophic** effects vary in different cases. Clinically, the ovaries, testes and uterus are most frequently involved. The muscles are weakened, from which curvatures develop. In short, any part depending on the twelfth dorsal segment for its nerve supply, may be affected and the usual effect is that of malnutrition.

THE FIRST LUMBAR.

The **first lumbar vertebra,** is a good type of the lumbar vertebræ which are the largest of the movable vertebræ. The body is kidney-shaped, that is the transverse diameter is considerably greater than the antero-posterior. The **notches** in the pedicles are deeper than those of the dorsal vertebræ, thus making the intervertebral foramina larger. The **spinous** process is short, large and thin, resembling a spatula in shape. It points in nearly a horizontal direction and its edges are slightly thickened. The **transverse** processes are smaller and more slender than those of the thoracic vertebræ. They are directed outward and slightly backward. The **articular** processes are quite large and the facets deep. The **superior** facets face backward and inward and are concave. The

inferior face in the opposite direction and are not so widely separated as the superior, since they are embraced by the superior facets of the vertebra below. The mammillary processes surmount the articular and

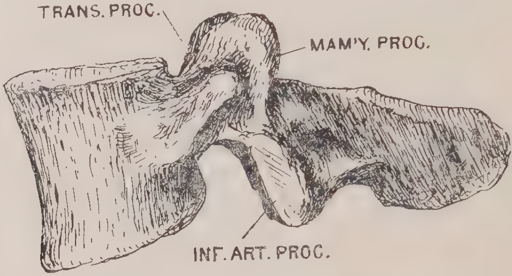

Fig. 60.—A lumbar vertebra.

consist of an elongated oval tubercle. They correspond to the superior tubercles on the transverse processes of the lower thoracic vertebræ. The vertebral or spinal foramina are triangular and larger than in the dorsal region.

The **intervertebral disc** is quite thick at this point and is slightly thicker in front than posteriorly, this causing the anterior curve in this region. THE CURVES OF THE SPINAL COLUMN DEPEND MORE ON THE THICKNESS AND ELASTICITY OF THE INTERVERTEBRAL DISCS THAN ON THE SIZE OF THE BODIES OF THE VERTEBRÆ. The disc is particularly liable to compression in the lumbar region on account of the strain and superimposed weight of the body.

The **mobility** of the articulations of the first lumbar is very well marked, all movements being represented. **Hypermobility** is quite common at the articulation between the twelfth dorsal and first lumbar. Strains of the articulations of the first lumbar are quite common, partly on account of the free mobility and partly on account of the position of the vertebra, its articulations bearing the brunt of the muscular exertions of this area.

The **ligaments** in this region are thicker and stronger than those above and are more subject to **irritation by which they are shortened and still further thickened.** The **muscles** of the back are also better developed, while to the body of the vertebra are attached the psoas magnus muscles. These muscles, when contractured, impair to a great extent the mobility

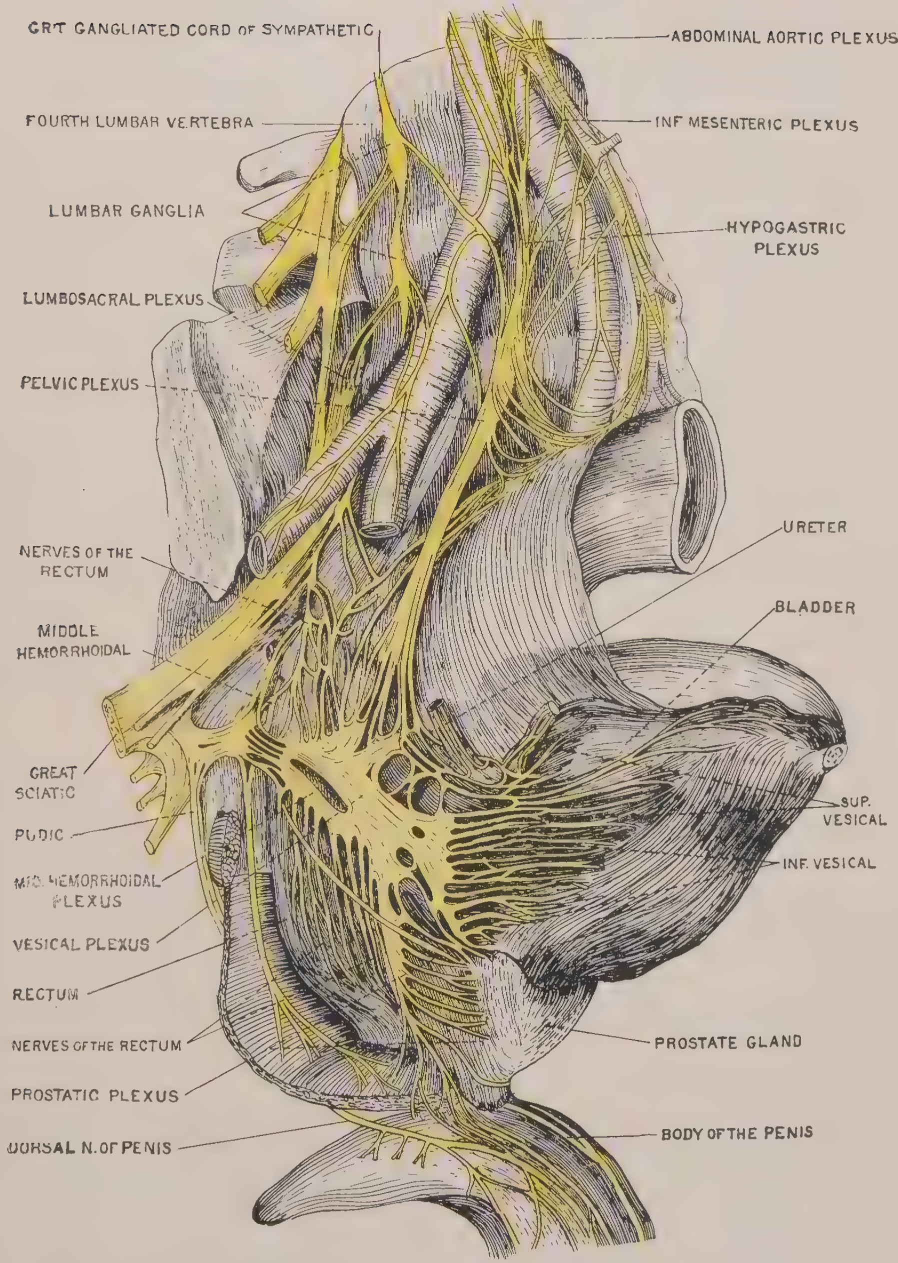

FIG. 61.—Showing nerves of the male pelvic organs, (after Spalteholz).

of the part and approximate the vertebræ, thus lessening the size of the intervertebral foramina. These foramina transmit **veins, arteries, lymphatics** and **nerves.**

The **veins** drain the first lumbar segment in particular, and the spinal cord and its coverings in general. On removing the posterior arches of the lumbar and thoracic vertebræ and slitting the coverings of the cord and nerve roots, these vessels in a well injected cadaver, can be readily outlined. The veins follow, or rather accompany the corresponding nerves, and are enclosed by the sheath of dura mater which surrounds the nerve root. A lessening of the size of the first lumbar intervertebral foramen, compresses the vein and some circulatory disturbance follows. Judging from clinical evidence, the effect is most marked in the corresponding segment. The congestion may at first be an irritative one, that is the nerve cells may be stimulated by this venous congestion, hence increased activity in parts innervated by this segment. The after effect, is, I believe, always that of lessening the activity of the cell, and diseases characterized by a lack of vitality or activity of the parts is the result. Constipation is a good example. The venous blood then passing through the first lumbar intervertebral foramen, comes mostly from the first lumbar segment and adjacent areas, and passes into the lumbar veins and then into the azygi veins.

The **arteries** that pass through the first lumbar foramen are branches of the lumbar. Their course is similar to that of the veins, that is they pass up the sheath which encloses the nerve roots and into the corresponding segment of the spinal cord. A lesion of this articulation will cause pressure on this artery, and arterial anemia of the parts supplied by it will result. The degree of anemia is governed by the extent of the anastomosis and amount of pressure. This anemia is not the ordinary form,—since the same pressure or obstruction causes a retention of the venous blood—but an arterial form of anemia, since the arterial blood is obstructed. The effect is similar to, if not identical with, that described above since the vein is always compressed and affected more than the artery on account of the character of its walls.

The **nerve** trunks and filaments affected by this lesion are the **ilio-inguinal, ilio-hypogastric, genito-crural, recurrent meningeal** and the filaments that go to form the efferent branches of the first lumbar sympathetic ganglion, viz., branches to the **renal plexus, aortic plexus** and the small branches that supply the vertebræ and ligaments. The le-

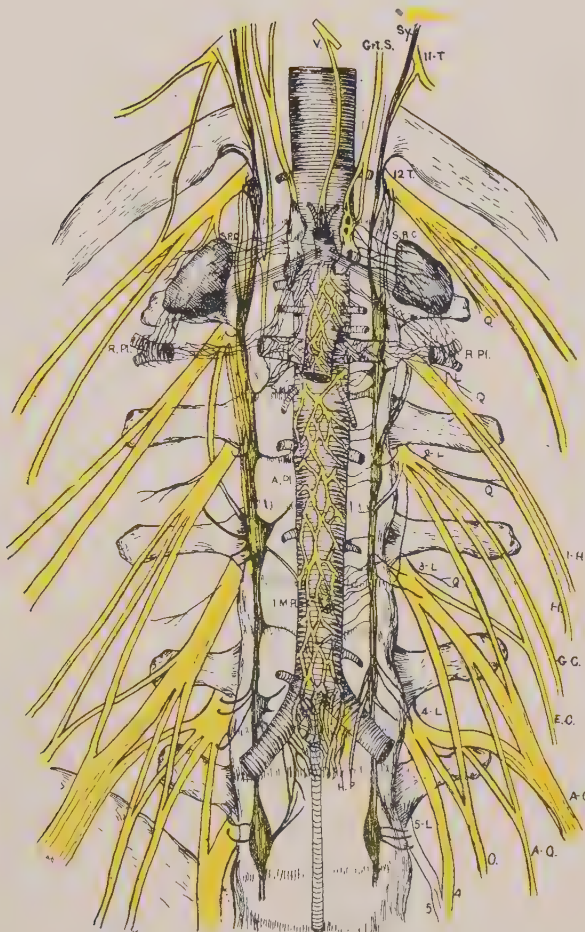

FIG. 62.—The lumbar portion of the sympathetic gangliated cord and lumbar plexus. (After Cunningham). I. M. P. inferior mesenteric plexus; A. pl. aortic plexus; S. M. P. superior mesenteric plexus; R. pl. renal plexus; S. R. C. suprarenal capsule; Va. vagus; Grt. S. great splanchnic; Sy. sympathetic gangliated cord; 11T, 12 T, 1 L, 2 L, 3 L, 4 L, 5 L, anterior divisions of spinal nerves; Q, nerves to quadratus lumborum; I. H. ilio-hypogastric; I. I. ilio-inguinal; G. C. genito-crural; E. C. external cutaneous; A. C. anterior crural; A. O. accessory obturator; O. obturator; 4, 5, lumbo-sacral cord; H. pl. hypogastric plexus.

sion may **irritate** the nerves in the foramen, hence a temporary increase in activity of parts supplied, but more commonly the lesion **inhibits,** to a certain extent, the passing of the nerve impulses, which is followed by a lessening of activity or functioning of the nerve and parts involved.

The **ilio-inguinal** is one of the anterior divisions of the first lumbar nerve. The anterior divisions form the lumbar plexus of nerves but each nerve seems to retain its individuality, that is it passes through the lumbar plexus with few communications. This nerve sometimes receives a filament from the last dorsal nerve and communicates with the ilio-hypogastric. It perforates the psoas magnus muscle, passes in relation with the quadratus lumborum and lies behind the kidney. It crosses the iliacus and pierces the transversalis near the crest of the ilium, supplying it and the internal oblique muscle. It then passes through the inguinal canal emerging at the external abdominal ring. It gives off muscular branches to the transversalis, internal oblique, rectus abdominis and the dartos. The condition of the dartos is indicative of the condition of the testicle. If relaxed, it shows a weakened condition but if the rugæ are firm, it is suggestive of a healthy testicle. The condition of the dartos is controlled in a great measure by this nerve. According to Cunningham, the ilio-inguinal nerve gives off cutaneous branches "which innervate the skin (1) of the anterior abdominal wall over the symphysis pubis, (2) of the thigh over the upper and inner part of Scarpa's triangle, and (3) of the upper part of the scrotum, and root and dorsum of the penis (of the mons Veneris and labium majus in the female)". A lesion of the articulations of the first lumbar, will affect this nerve hence there may be sensory disturbances in the above mentioned areas, pain being the usual form of disturbance. Many a case of pruritus vulvæ and pain in the external genitalia, is due to a subluxation of the first lumbar vertebra. The explanation is that the lesion stimulates some or all of the filaments forming this nerve and as a result, impulses arise that are carried over the usual paths to the sensorium, but there is a mistake as to the source and the pain is referred to the periphery of the nerve, the accustomed place. This nerve may be affected by a strain of the psoas muscle or by a lesion that produces contracture of it.

The **ilio-hypogastric** nerve also comes from the first lumbar segment, often in common with the ilio-inguinal, and its course is about the same, it piercing the psoas and transversalis muscles. It follows the crest

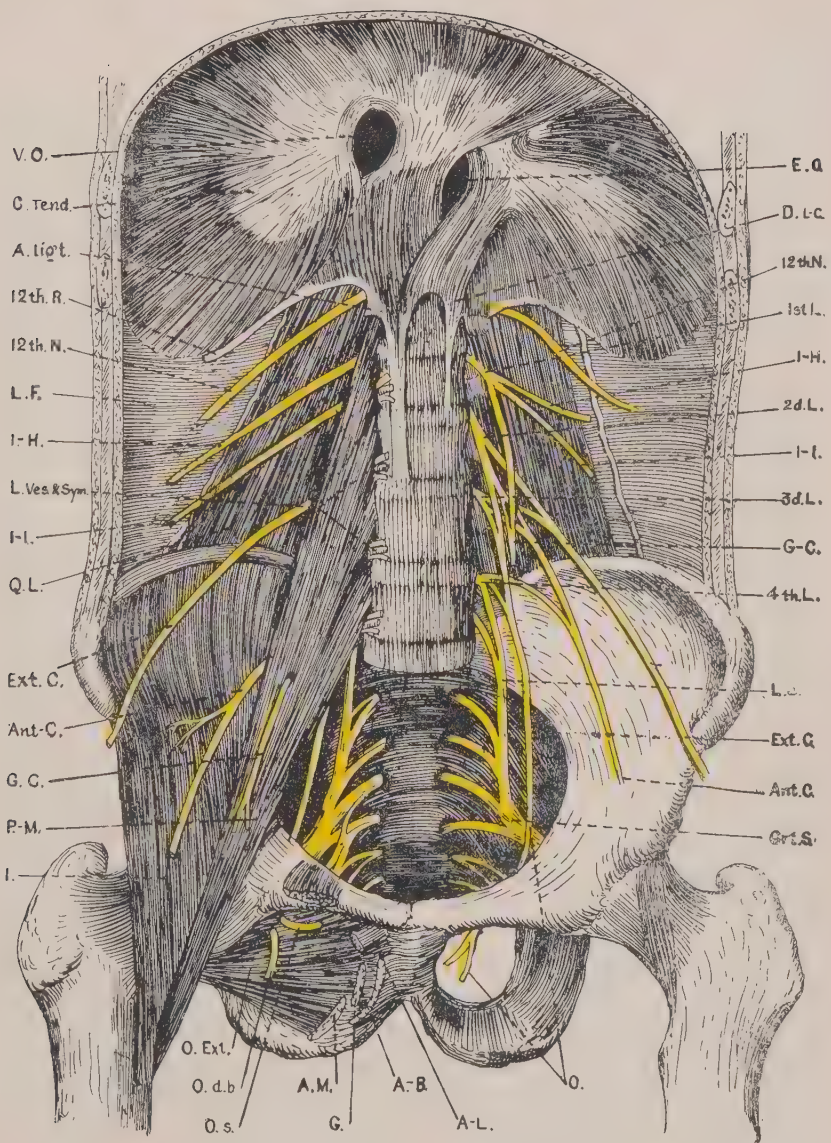

FIG. 63.—Showing the posterior abdominal wall with its muscles and nerves (After Cunningham). V. O. vena caval opening; C. tend. central tendon; A. ligt. arcuate ligament; 12th R. twelfth rib; L. F. lumbar fascia; I. H. ilio-hypogastric n.; L. vis & sym. lumbar vessels and symphathetic n.; I. I. ilio-inguinal n.; O. d. b. deep branch of obturator n.; E. O. esophageal opening; D. lc. left crus of diaphragm; A. L. adductor longus; A. B. adductor brevis; G. gracilis. Note the relation of the lumbar nerves to the psoas muscle.

of the ilium, running between the transversalis and internal oblique muscles and near the anterior superior spine, divides into an iliac and hypogastric branch.

The **iliac** branch is supposed to correspond to the lateral cutaneous branch of an intercostal nerve. It pierces the internal oblique muscle thus becoming cutaneous, and supplies the skin over the upper and outer side of the buttock behind the distribution of the lateral cutaneous branch of the last thoracic nerve. The **hypogastric** branch passes forward and, piercing the internal oblique, supplies the integument over the hypogastrium. The ilio-hypogastric nerve supplies the internal and external oblique, transversalis and rectus abdominis.

The ilio-inguinal and ilio-hypogastric nerves are often the seat of referred pain. Renal colic causes pain in the areas supplied by the ilio-inguinal nerve. The possible explanation is that the same segment (first lumbar) supplies both, and that irritation to the sensory nerves of the kidney and ureter will produce both a motor and sensory effect in the parts supplied by the cerebro-spinal nerves which comes from the same spinal segment. Ovarian colic will have a similar effect. Stimulation of the pudendum will affect the ovary possibly directly, or at least indirectly, through the general effect on the sexual apparatus.

The **genito-crural nerve** is also affected by a lesion of the first lumbar articulations. It pierces the psoas muscle, passes down in relation with the external iliac vessels and behind the ureter and near Poupart's ligament, it divides into two unequal nerves, the **genital** and **crural** branches. Its function and distribution will be considered under discussion of the second lumbar segment since the greater part of the nerve comes from the second.

The **posterior division** of the first lumbar nerve divides into the usual internal and external branches. The internal ends in the multifidus spinæ muscle. The external enters the subcutaneous tissue, crosses the crest of the ilium, and, with the second and third, form the superior clunii nerves. This branch supplies the integument of the gluteal region.

According to Quain the first lumbar ganglion sends a nerve to the renal plexus. The impulses passing over this nerve originate in the spinal cord, the first lumbar segment. In other words, the filaments that go to make up this nerve are prolongations from cells located in spinal cord. These filaments pass through the intervertebral foramen,

forming a part of the trunk of the common nerve, the first lumbar.

A lesion of the first lumbar articulation will lessen the size of this foramen thus interfering with (1), the nerve by pressure on it, or (2) the blood-vessels carrying nutrition to the cells that give rise to the nerve filaments. This nerve (renal branch of the first lumbar ganglion), carries motor, vaso-motor, and trophic impulses to the kidney and ureter and possibly sensory impulses from the kidney and ureter to the spinal cord.

The principal efferent branches of the first lumbar ganglion go to the aortic and hypogastric plexuses. The **aortic** or **intermesenteric plexus** (plexus aorticus abdominalis) placed along the abdominal aorta, occupies the interval between the origins of the superior and inferior mesenteric arteries. It consists, for the most part, of two lateral cords which are connected above with the semilunar ganglia and renal plexuses and extend downward on the sides of the aorta, meeting in several communicating branches over the front of the vessel. The cords receive branches from some of the lumbar ganglia and at the points where they join, there are often small, ganglionic enlargements which are more distinct in the infant. Several filaments pass to the root of the inferior mesenteric artery to form the plexus on that vessel, and in connection with these is the inferior mesenteric ganglion placed below the origin of the artery. "The aortic plexus furnishes the inferior mesenteric plexus and part of the spermatic, gives some filaments to the lower vena cava, and ends below in the hypogastric plexus." (Quain.) The cells giving origin to these different nerve fibers are for the most part, located in the spinal cord and as in the case of the renal branch, the impulses pass over the filaments that form a part of the ventral root and common nerve trunk. A lesion of the first lumbar articulation will affect these filaments in a way similar to those forming the renal branch described above. The aortic plexus is motor to the intestines, this part especially supplying the cecum and ascending colon. It also supplies the ovary and testicle and, possibly, all the structures supplied by the hypogastric plexus, viz., the uterus, vagina, prostate and rectum. It is in part vaso-motor to the abdominal aorta, inferior vena cava, mesenteric vessels, ovarian and spermatic vessels, vesical, hemorrhoidal, uterine and possibly the vaginal vessels. The lesion usually intercepts the impulses, or at least lessens them, hence dilatation of the vessels is the common sequel. From congestion many forms of disease may arise. This plexus is also

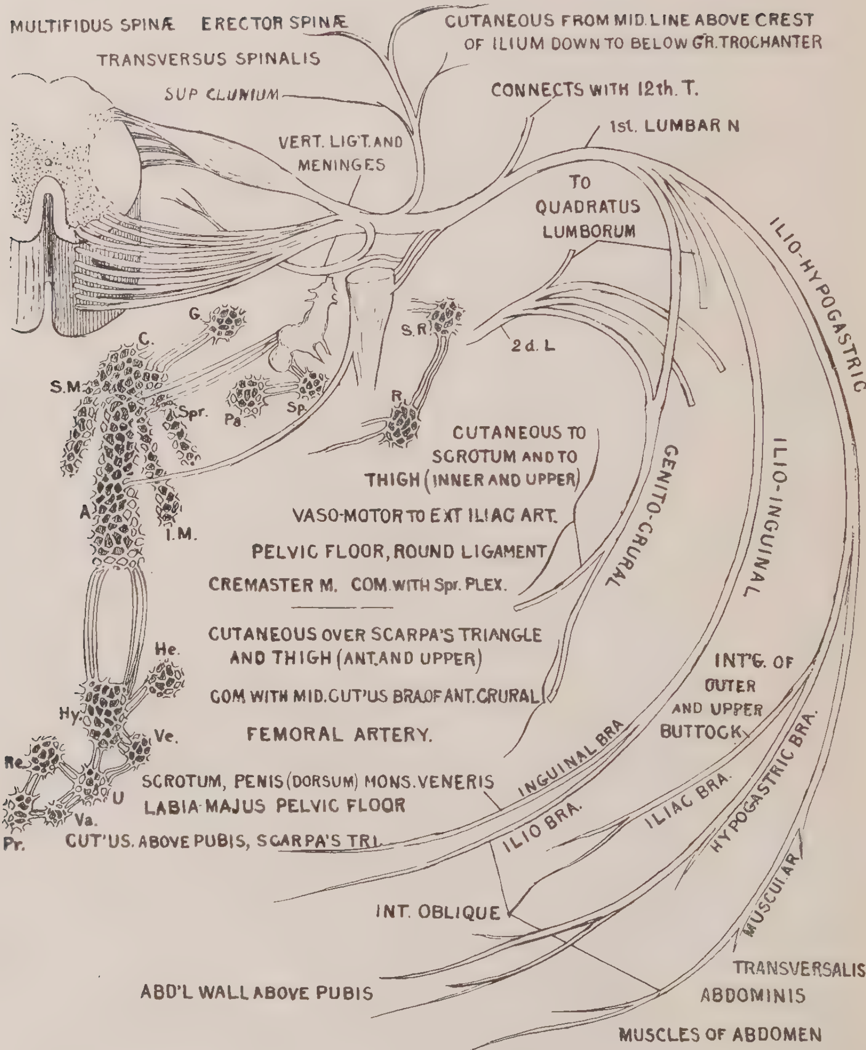

FIG. 64.—The first lumbar segment of the spinal cord with its nerves and their distribution.

secretory to the above parts, hence secretion will necessarily be impaired by the lesion, if it affects this plexus, and it usually does. The left strand of fibers almost entirely forms the inferior mesenteric plexus. Thus lesions affecting the foramina on the left side, are the more important so far as the effects on the bowel are concerned.

The first lumbar sympathetic ganglion also furnished filaments to the first lumbar vertebra and its ligaments. An impairment of these nerves results in a weakened spinal column. In other cases, the spine becomes rigid from contracture of these ligaments. Caries of the vertebræ is also a sequel to a lesion affecting these nerves.

The **recurrent meningeal** nerve is, like the other recurrent nerves, formed by filaments from the cerebro-spinal and sympathetic nerves. It is vaso-motor to the spinal cord, first lumbar segment, and the meninges. The nerve passes through the intervertebral foramen and thus is subject to pressure when the vertebræ forming this foramen are subluxated. As a result, anemia or congestion of the parts supplied, is the result.

The **disorders most common** are lumbago, affections of the kidney, such as gravel, albuminuria and Bright's diseases, and bowel disorders such as constipation, diarrhea and flux. Bladder disturbances are also frequent when this lesion exists. Quain states that this segment furnishes nerves that are motor to the uterus, bladder and circular muscle fibers of the rectum; vaso-motor to the abdominal vessels and vessels of the penis and lower limbs.

THE SECOND LUMBAR.

The **second lumbar vertebra** is a typical one, so needs no separate description. Its size varies with the degree of muscular, and the general osseous development of the patient. Its articular facets are large and the articulations strong and apparently secure, on account of the depth of the facets. If this were not the case, lesions would be more common than they are, on account of the lumbar vertebræ not being reinforced by the ribs. Notwithstanding this, lesions are quite common. The **approximation** of adjacent vertebrae is one of the most common. A posterior condition is also common but does not cause so much trouble in proportion to the degree of irregularity as do other lesions, as for example, an anterior condition. Whenever this bone is moved beyond the physiological range of motion, the tissues attached to

it are either stretched or broken. The articular facets, in spines in which there has been a forcible and abnormal flexion or extension, are moved abnormally far or separated so that the function of the joint is impaired.

The **tissues involved** are the periosteum, peritoneum, muscles, ligaments and the fascia attached to the vertebra. The effects of the lesion may be confined to those tissues attached to the vertebra and would be similar to those from sprain of any joint, such as edema and tenderness with pain on attempt to use it. The intervertebral foramen would be lessened in size partly by change in position of the parts forming it and partly by the thickened ligaments in relation. The effects on the veins and arteries are very similar to those of a lesion of the first lumbar on the vessels in relation with it, and these have been considered above.

The **nerves** that are formed from filaments passing through the second intervertebral foramen and would be affected by the lesion, are the genito-crural, external cutaneous, anterior crural, obturator, recurrent meningeal, posterior division of the second lumbar nerve and the nervi efferentes which branch from the second lumbar ganglion, viz., branches to the aortic and hypogastric plexuses and to the second lumbar vertebra and its ligaments.

The **genito-crural** nerve, soon after emerging from its foramen, enters the psoas muscle and after passing through it into the psoas fascia, divides near Poupart's ligament, into the genital and crural branches. The **genital** branch passes across the iliac vessels into the inguinal canal, entering it at the internal abdominal ring. It traverses this canal in company with the spermatic cord and supplies the iliac artery, cremaster muscle, integument of the scrotum and a part of the skin of the thigh in relation. In the female, it accompanies the round ligament to its destination and is also supposed to send some motor filaments to it. The **crural** branch passes under Poupart's ligament into the thigh and becomes cutaneous by passing through the saphenous opening. It supplies the skin over Scarpa's triangle not supplied by the ilio-inguinal and, communicating with the middle cutaneous of the anterior crural, sends some filaments to the femoral artery.

The lesion of the second lumbar articulation will **stimulate** or **inhibit** the impulses that should normally pass over this nerve. If they are inhibited, there will be impairment or loss of sensation in the skin over the upper and inner part of the thigh and the skin of the scrotum. The scrotum will not respond to cutaneous stimulation, it becomes re-

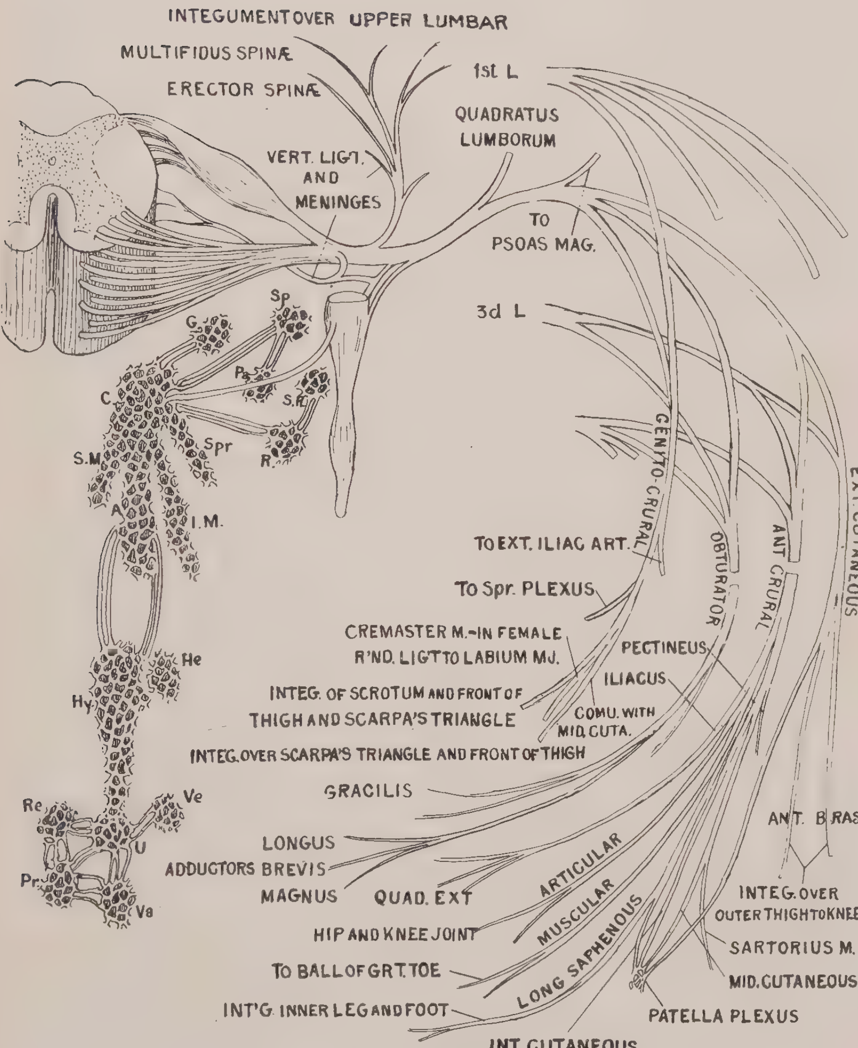

FIG. 65.—The second lumbar segment of the spinal cord with its nerves and their distribution.

laxed and the testicle is no longer held in its proper place but becomes pendulous. The cremasteric reflex depends to a great extent on the condition of the cutaneous nerves, and in this condition it would be lessened or lost. If the nerve were stimulated by the lesion, there would be hyperesthesia or pain in the above areas.

This nerve is often the seat of pain referred from the ureter as in renal colic. The explanation is that the impulses generated by the calculus stimulating the sensory nerves lining the ureter, are carried to the second lumbar segment, thence to the sensorium over the same pathway as are the impulses from the genito-crural nerve and thus the sensorium is mistaken in part at least, as to the location of the painful stimulus. The pain is referred to the inner side of the thigh or scrotum, sometimes the penis, and retraction of the testicle is generally present.

This nerve supplies motor impulses to only one muscle, the **cremaster.** This muscle is named from its function, that of suspending the testicle. It is regarded as a detached portion of the internal oblique and is formed into several loops that enclose the testicle and lower part of the spermatic cord. It arises from the middle portion of Poupart's ligament and is inserted into the spine of the pubic bone and the fascia in relation. The cremaster muscle is peculiar in that its fibers are separate thus forming a series of loops. Its function is to draw the testicle upward and its contraction is involuntary. It can be stimulated to contraction by irritation of the adjacent skin. The height of the testicle is ordinarily an indication of its strength. A pendulous testicle is a weak one, while one that is held quite closely to the pubic bone, is usually in a healthy condition. The cremaster muscle supports the testicle, hence the condition of it is a guide to the condition of the testicle. In short, if the cremasteric reflex is lessened or lost and if the testicle is pendulous, there is loss of sexual strength.

The **femoral artery** may be affected by the lesion since it is innervated in part, by the genito-crural nerve which is affected by the lesion, because of the relation of its roots to the articulation.

The **external cutaneous** nerve passes through the psoas magnus muscle, crosses the iliacus, passes under Poupart's ligament and becomes cutaneous immediately below the anterior superior spine. It divides into an anterior and a posterior branch. The anterior is the larger and supplies the integument on the outer side of the thigh almost to the knee. The posterior branch supplies the lower part of the buttock

and the upper part of the outer aspect of the thigh. It is entirely sensory, hence the lesion of the second lumbar articulations will, if it affects this nerve, produce numbness or pain in the above areas.

The **anterior crural** and **obturator** nerves may be affected by the lesion. The effects will be considered under the discussion of the third and fourth lumbar. The posterior division of the second lumbar nerve supplies in part, the muscles of the back in relation and in conjunction with the first and third, supplies sensation to a part of the integument in the middle lumbar region.

The branches of the second lumbar ganglion contribute to form the **aortic plexus** which in turn, helps to make up the **ovarian, inferior mesenteric** and **hypogastric plexuses.** According to McClellan, the hypogastric plexus receives some filaments directly from the lumbar ganglia. These plexuses control the vaso-motor impulses to the bladder, vas deferens, round ligament, rectum, intestines and the uterus. They are, in all probability, sensory, secretory, vaso-motor and trophic to the genitalia and the lower intestinal tract. These plexuses are affected by the lesion of the second lumbar, because the subluxated bone presses on or otherwise disturbs the impulses from the spinal cord that supply them. These impulses pass over filaments that connect the organs and structures named above. These nerve filaments pass through the intervertebral foramen and this foramen is practically always lessened in size, by the lesion. As a result of the lesion, there may be congestion of the genitalia on account of inhibition of vaso-motor impulses. There may be anemia if the lesion causes prolonged stimulation. Tumefactions of the uterus result in some cases in consequence of the congestion. The continued congestion leads to deposits. The rigid lumbar spine is the most common of all bony lesions producing tumors of the uterus. The tumor is the result of the disordered innervation of the uterus, from the rigidity. The large colon may become diseased from vaso-motor disturbances. If the vessels are dilated, diarrhea may result, or in extreme cases, bloody flux. These conditions result from impairment of the lower bowel, hence the lesion is usually in the middle and **lower lumbar regions.**

If the nutrient nerve to the round ligament is impaired, the ligament relaxes and the uterus, no longer firmly held in anteversion, becomes retrodeviated from any exciting cause. If the ligament is stimulated the patient will complain of a drawing or pulling sensation along the course of the ligament.

The **bladder** is affected because the motor supply is intercepted or otherwise affected by the lesion. This is because the nerve filaments pass through the intervertebral foramina in relation with the affected vertebra, the second lumbar. The muscle fibers relax if the lesion is paralytic, contract if it is irritative, hence the condition called vesical tenesmus. The **uterus** is also affected in a similar way.

The **rectum** receives motor impulses from this segment by way of the aortic or hypogastric and hemorrhoidal plexuses. It also receives vaso-motor impulses in the same way. There may be relaxation or contraction, or if the vaso-motor filaments are disturbed, hemorrhoids may result.

This segment contains three **centers,** the functions of which have been quite clearly demonstrated experimentally and clinically, viz., **defecation, micturition** and **parturition.** A center consists of a group of cells that transfers afferent to efferent impulses. To do this there must be an afferent nerve which keeps the center informed as to the condition of the part, a center or group of cells to receive the afferent impulses, and an efferent nerve by which the center can send impulses to the part. **Defecation** is a reflex phenomenon, hence there must be a stimulus, a sensory nerve to receive and transmit the impulses, a center to receive the impulses and a motor nerve to transmit the impulses to the muscles in relation with the part stimulated. In defecation the stimulus is the presence of fecal matter in the rectum. Ordinarily, the rectum is empty except at a time just prior to defecation. When it is impacted or engorged, constipation exists. I have partly determined this in the female by hundreds of vaginal examinations. The sensory or afferent nerves are branches of the hemorrhoidal and the inferior mesenteric plexus. The efferent nerves are also a part of these plexuses. In order then that defecation be normal, the sensory nerves must be of normal irritability, the line of communication between the bowel and the center, and the center and the bowel, unbroken, and the center properly nourished. The afferent and efferent impulses pass through the second lumbar foramen over the common nerve trunk. Therefore, a lesion at this articulation may produce constipation by (1), pressing on the afferent nerve thus interfering with the impulses that arise from the pressure of accumulated feces; (2), by pressing on the efferent nerve, hence the motor impulses do not reach the bowel; and (3), by interfering with the nutrition of the center, thus making it less active and less susceptible to the afferent

impulses, that is the afferent impulses reach the center but the cells do not respond to the stimulation, hence no efferent impulses are generated although the pathway is unobstructed. It must be borne in mind that all the afferent impulses do not reach the defecation center by way of the sensory nerves connecting directly with the second lumbar segment, but that some reach it by the first, third, fourth, and possibly the fifth. After reaching the spinal cord, the impulses may travel through several segments, usually from below upward, so that constipation may be, and usually is produced by **lesions at and below the second lumbar vertebra.** The osteopathic treatment removes these obstructions by restoring the foramina to normal size, thus relieving pressure on the nerves and blood-vessels. A palliative effect may be obtained by artificially stimulating the sensory nerves lining the bowel, thus increasing the number and intensity of the impulses that are normally transmitted to the defecation center. These impulses may be increased to such an extent that they will overcome slight obstructions and awaken an inactive center, so long as the stimulation is applied. This may be accomplished by the use of certain drugs which directly stimulate the nerves, or indirectly through increase of secretion of bile and succus entericus; by the introduction of water into the bowel, which stimulates the sensory nerves; or by mechanical stimulation, as in dilating the rectum. All these treatments are palliative in that they do not remove the cause. After continued use, they lose their power of stimulation and a change has to be made, and the constipation is made the worse by such treatments.

The opposite condition (diarrhea) may result from this lesion, if it stimulates (1), the afferent nerve as it passes through the foramen, (2), the center, through increasing the amount of arterial blood, and (3), the efferent impulses by stimulation of the motor nerve while it is in relation with the vertebra. The usual **palliative treatment** for this condition is **inhibition** applied to the lumbar area of the spine. The best way to give this treatment is to extend the spine over the hand or knee applied to the second, third or fourth lumbar spine. This lessens the size of the foramina, therefore shuts off (1), the amount of afferent impulses, (2), the nutrition of the center, it then becoming less active, and (3), by inhibiting the motor or efferent impulses. To cure this condition the irritation must be removed permanently, which is accomplished by correcting the lesion that causes the irritation. The other palliative measures often resorted to are (1), drugs which deaden the sensory nerves

supplying the bowel, and (2), foods that have little residue, such as cheese and boiled milk. These do not remove causes, hence soon become of no value even as palliative measures. The lesion may so affect the bowel that the peristalsis is so increased that tenesmus, eversion of the bowel and discharge of blood may follow. In such cases the sensory nerves are more sensitive, the center more active and the motor impulses markedly increased in number and intensity.

The **micturition** center, also located in this segment, may be affected by the lesion. Micturition is also a reflex process, the accumulation of urine in the bladder furnishing the stimulus, the vesical plexus the afferent and efferent nerves. When the amount of urine reaches a certain point and the pressure a certain degree, the center is so informed and the bladder wall contracts, while the sphincter vesicæ relaxes. The lesions, as in constipation, may (1), lessen the irritability of the sensory nerves innervating the mucous membrane of the bladder, principally the trigone; (2), inhibit the activity of the center; (3), interfere with the passing of motor impulses to the bladder or (4), interfere with the nutrition of the muscle fibers of the bladder wall. In such cases the bladder becomes distended with urine and finally the sphincter muscle is overcome, allowing the urine to dribble away. If the lesion is an irritative one, the nerves or center, taking part in the reflex phenomenon, are stimulated and frequent micturition results. In persistent and bad cases, tenesmus or spasm of the bladder results. The bladder is empty but contraction continues until it becomes quite painful. The sacral nerves may have something to do with some of these cases hence the lesion may be lower in the spine or pelvic bones. Inhibition at the second lumbar will often relieve vesical tenesmus. This lesion may also produce cystitis and possibly calculi, on account of incomplete evacuation of the bladder from weakness. **Cystitis** results from retention of urine and from vaso-motor disturbances. Bed-wetting in children may also come from this lesion. The brain ordinarily exerts an inhibitory influence on the spinal centers but in enuresis this connection may be impaired by the lesion. A better explanation is that the lesion irritates the micturition center. This center should be in a state of rest during sleep but the lesion keeps it irritated so that a little urine will set up impulses strong enough to affect and bring into activity the already irritable micturition center. Inhibition at the second lumbar just before retiring will, in most ceases, prevent the bed-wetting for that night. If only the inhibition

is given it will have to be repeated every evening. This treatment seems to temporarily overcome the effect of the lesion, that is the irritation is in a measure counteracted. **To cure the case** the cause of the irritation must be removed or counteracted and this is accomplished by **correcting the lesion.** Children often outgrow the disorder because in time the lesion ceases to exert an irritating influence, or nature succeeds in overcoming or repairing the injury.

The **parturition** center, so-called from the role it plays in parturition, is also located in the second lumbar segment. It is as much of a **menstruation** center as it is a parturition center, for it controls the contraction of the longitudinal, and possibly the circular, muscle fibers of the uterus. In parturition, which is a reflex process, the stimulus is the fetus in utero, the afferent nerves the filaments composing a part of the ovarian and uterine plexuses. The efferent impulses are carried over other filaments of the same plexuses. If the lesion stimulates the center or its nerves, to any marked extent, abortion may result. If by a treatment the afferent or efferent nerves or the center are stimulated very much, contraction of the uterus to such an extent that pregnancy may be terminated, is possible but uncommon. During labor, stimulation of these nerves increases the intensity and frequency of the uterine contractions. Inhibition has the opposite effect. A lesion of the second lumbar may disturb parturition by (1), affecting the afferent impulses; (2), by affecting the center; (3), by impairing the activity of the efferent nerve or (4), by affecting the nutrition of the muscle fibers of the uterus. The usual effect is lessened activity, that is the lesion inhibits the function of the center and **inertia uteri** in some form or degree, is the result. The explanation is that the center is on the inside of the spinal canal and the uterus is in the abdominal cavity and the nerve filaments connecting them must pass through the intervertebral foramina. In the case of a lesion, these filaments are affected hence their conducting power is lessened; or else the lesion disturbs the nutrition of the parturition center, thus making it less susceptible to the impulses carried to it by the sensory nerves. In all such cases, labor can be made comparatively easy by **antepartum treatment.** This treatment consists of **correcting all lumbar lesions** whether a single vertebra is affected or the lesion consists of a stiffening of the articulations. These lesions make labor hard, as mentioned above, by interfering with the reflex process. Labor is made easier by osteopathic antepartum treatment

since by it lesions of the spine are corrected, thus relieving and removing obstructions to (1), the afferent impulses, (2), to the blood supply and drainage of the parturition center, restoring it to normal activity, and (3), to the efferent nerve fibers. These results are accomplished to a great extent, if not entirely, by increasing the size of the intervertebral foramina, or rather by restoring them to their natural size. In some cases this is hard to do, in others impossible, on account of the permanent or chronic changes in the thickness of the intervertebral discs and the thickening of the spinal ligaments in relation with the foramen. In the treatment of pregnant cases, precaution should be taken not to treat too hard, that is do not stimulate the uterus too much or too suddenly, or abortion may result. In cases in which abortion is likely to occur, the treatment is especially indicated and that in the lumbar area, but be careful how you give it. The writer knows from experience that good, thorough treatment applied to the lumbar spine for the purpose of restoring normal mobility to every articulation is of great value in making labor easy and in preventing complications and sequellæ depending on a weakened uterus, such as postpartum hemorrhage and subinvolution.

The **menstrual function** is also disordered by this lesion affecting the center or its nerves. It is the motor center for the uterus hence any disorder of the uterus, especially the fundus and body, may be the result of a lesion of the second lumbar articulation. **Dysmenorrhea** is the most common. This results because the lesion affects the afferent or efferent nerves, hence there is imperfect contraction. In the case of menstruation, the menstrual flow is the stimulus; the rest of the reflex arc is the same as that for parturition. The lesion may stimulate the center or any part of its nerves, causing excessive contraction or "cramps." The irritation may continue for several days after the discharge ceases causing post-menstrual pain. It may occur at the mid-intermenstrual period, hence the intermenstrual pain. The lesion may inhibit the center or its nerves. Blood will then accumulate in the uterus and undergo coagulation. The afferent impulses are lessened, as are the efferent, and the uterus with difficulty expels the menstrual flow. The explanation is about the same as that given under parturition, that is the lesion lessens the size of the intervertebral foramina, hence interferes with the passing of blood and nerve impulses through them on account of which, the center is crippled as are the connections with the uterus disturbed.

Almost any disorder of the lower bowel and pelvic organs may result from a subluxation of the second lumbar vertebra because nearly, if not all, depend to a great extent, for their nutrition, secretion, blood, sensation and motion upon their nervous connection with the lumbar spinal cord, and the second lumbar segment is in all probability the most important part. This connection is partly broken by a lesion of the second lumbar, because a great many filaments pass through the foramina in relation and these are always affected by a subluxation.

Lumbago quite often comes from subluxation of the second lumbar, because it affects the innervation of the spinal muscles, the sensory innervation of the joint and the mobility of the joint is either lost or motion in it, causes pain. Like any dislocated bone, the ligaments become tender, and this alone will prevent movement on account of pain. In chronic cases, the effect depends on the degree of irritation of the sensory nerves, or on the muscular changes brought about as a result of the lesion, and on the changes in the articulation itself. The ordinary "stitch" in the back is commonly directly due to a subluxation of a vertebra, usually a lumbar.

This lesion will weaken the **spinal column,** leading to curvatures or in mild cases, to simply an ache or weakness of the back. The **spinal cord** or rather its prolongation, may be compressed by a dislocation of the vertebra. A subluxation of the second, will affect the corresponding segment with impairment of function of every part relying for its ininnervation, upon this segment or any segment below it. If a transverse myelitis takes place paralysis of the parts below would follow.

THE THIRD LUMBAR.

The **third lumbar** vertebra is quite large and all its prominences well developed for the attachment of muscles. It differs little from the first and second. Its movements are fairly well marked in the normal subject but in the aged and in cases in which the spine is in any way diseased, the movements are impaired. The transverse processes are longer than those above. Lesions of two articulations may take place, that is the vertebra may be slipped on both its inferior and superior articulations, but this form of lesion is not so common as the one in which one articulation is involved, that is one part of the spinal column is twisted or otherwise displaced on the lower segment.

The **ligaments** in this region are thicker and stronger and the facets

deeper than above. It takes more force to dislocate or even sprain a lumbar articulation than a thoracic or cervical, but the lumbar region is subject to many times more strain than any other part of the spinal column and on this account a sprain or subluxation of a lumbar vertebra, occurs almost as often as that of a cervical and more frequently than that of a thoracic.

A lesion of the third lumbar articulation will produce effects on the adjacent structures similar to that from a lesion of the second lumbar. The ligaments will at first be thickened, congested and tender, later on they contract and an approximation, with a thinning of the discs is the result. This always lessens the mobility hence we speak of it as a smooth spine. The muscles and other tissues attached to it are also affected.

The most important of these muscles are the **multifidus spinæ, erector spinæ** and the **psoas magnus.** An irritative lesion of the third, will cause contracture of one or more of these muscles. If of the multifidus spinæ, the spine will be drawn to the side of contracture on account of the way the tendinous fibers are inserted and on account of their length, they being very short. If of the erector spinæ, extension of the spine becomes imperfect or difficult and the spine is swerved toward the affected side. If of the psoas magnus, flexion of the thighs on the abdomen or of the spine become difficult and the patient walks with a stoop and a stiffened gait. If the lesion is a paralytic one, the effect is one of relaxation and weakness. The various movements of this part of the spine become impaired and the patient has a weak back. Paralysis of one of the spinal muscles permits the unopposed muscle on the opposite side to draw the spine to that side and change of contour, often to the degree of a curvature, is the result.

The **veins** and **arteries** passing through the formina are obstructed, and the parts drained by the veins and those supplied with arterial blood by the arteries disturbed, the spinal cord being the most important.

The **nerves** affected by this lesion are the **anterior crural, obturator, external cutaneous, accessory obturator, posterior division** of third lumbar, **aortic** and **hypogastric plexuses** with their branches, the **gangliated cord, recurrent nerve, rami communicantes,** and branches to the vertebra and its ligaments.

The **anterior crural** is the largest of the nerves of the lumbar plexus. It is formed principally from the third lumbar segment, although fila-

ments from the fourth lumbar, and the second and sometimes the first lumbar, joint the root from the third, to form the nerve. It pierces the psoas magnus muscle. Deaver says that in psoas abscess "it is left intact, although the muscle may be entirely removed by necrosis." Many a pain and ache in the lower limbs is due to disease or contracture of this muscle affecting this nerve which pierces it. The nerve passes out under Poupart's ligament, below which it becomes somewhat flattened out and divides into two parts, one that is principally cutaneous and one that is almost entirely motor. Before it emerges from the abdomen, it gives off muscular branches to the iliacus, some filaments to the femoral artery, and some anatomists claim that some fibers pass from this nerve, in company with the nutrient artery, to the femur. The middle cutaneous supplies sensory filaments to the front of the thigh and inner side of the patella. The internal cutaneous supplies sensation to the integument of the anterior and inner portion of the thigh, outer side of the knee, inner side of the calf of the leg and foot. It also supplies the pectineus muscle. The sartorius is supplied by the middle cutaneous; the rectus femoris and hip-joint by filaments from other branches of the anterior crural.

These branches to the hip-joint and the femur are of importance in cases of malnutrition,such as tuberculosis of the joint or possibly in cases of arrected or improper development of the joint or bone. Lesions of the third lumbar articulation interfere with the nutrition of the hip-joint and the femur through effects on this nerve and are responsible for many cases of arrested development and disease of the hip-joint. In the treatment of tubercular disorders of the hip-joint and of the femur, the lumbar spinal treatment is more important than any other, since it is the rule for a lesion to be present there in such cases. In fact, the cure depends on this treatment since by it the cause of the disease is removed. In all cases of dislocation of the hip, treatment applied to this region is often very helpful in restoring strength and nutrition to the parts, through removing pressure on, and other disturbances of, the anterior crural nerve.

The branches which supply the vastus externus and internus, also supply the knee-joint. The **long saphenous,** so named from its length and relation to the vein of the same name, supplies sensation to the integument over the knee-cap and inner side of the calf of the leg and foot. A lesion of the third lumbar articulation would affect this nerve

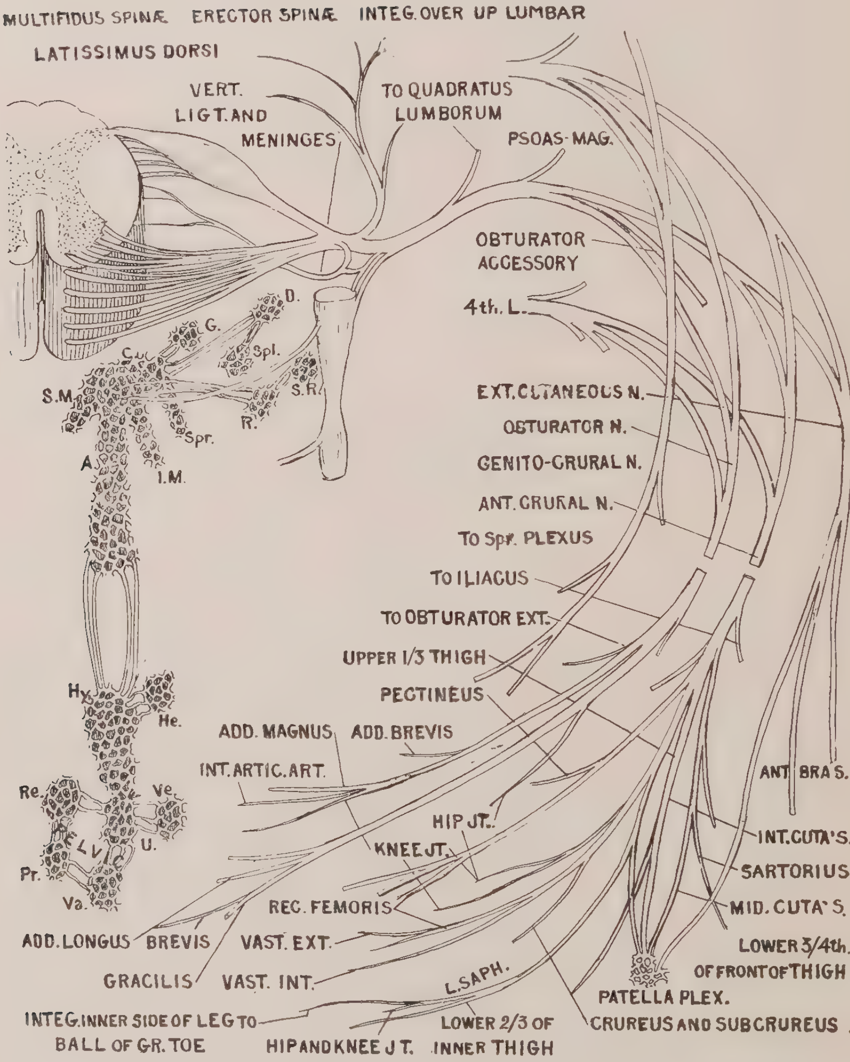

FIG. 66 —The third lumbar segment of the spinal cord, with its nerves and their distribution.

by producing pressure on the roots forming it, by interfering with the nutrition of the cells or by causing contracture of tissues pierced by the nerve. If the lesion stimulates the nerve, there will be pain in the parts supplied with sensation by it, viz., the hip-joint, knee-joint, integument over the anterior and inner side of the thigh, leg and foot. Pain in the knee may be the result of a lesion of the third lumbar articulation or hip. The common reflex pain in case of dislocated hip or of coxitis, is pain in the knee. The explanation is that the irritation applied to one part may, and does cause pain to be referred to another, on account of which errors in diagnosis have been made.

The **muscles** of the front of the thigh become contractured as a result of an irritative lesion of the third lumbar and the condition is often diagnosed as "rheumatism" of the muscles. The **femoral** artery becomes smaller in cases in which such lesions exist, and the lower limb is not well nourished. The branches to the hip-joint, femur and muscles are also nutrient. If the lesion inhibits the function of this nerve, there will be weakness of the limb, malnutrition of the hip-joint, numbness of the integument and atrophy, with a weakening of the muscles, neuralgia, rheumatism, weakness, edema, malnutrition and deformities of the lower limb. In spastic paraplegia, the dragging of the toe is due in part, to impairment of this nerve and partly to inability to flex the ankle. The patient leans forward in order to be able to take a step on account of inability to flex the thigh. In this way, the line of gravity is brought anterior to the base.

The **obturator nerve** also comes principally from this segment. It pierces the psoas muscle, and emerges from the pelvis through the thyroid or obturator foramen. While in the foramen, it divides into an anterior and posterior branch. The anterior, supplies the hip-joint, the gracilis and adductor longus muscles and the femoral artery. According to Hilton, this nerve passes in relation with the sacro-iliac synchondrosis and sends a filament to the articulation. From this it is then possible for a lesion of the articulations of the third lumbar vertebra to produce pain in the hip, synchondrosis, and spasm or contracture of the adductor muscles

The posterior division supplies the remaining adductors and the knee-joint, and occasionally supplies the integument over the inner side of the thigh. In spastic paraplegia there is often spasm of the adductors and the patient has the cross-legged progression. The lesion af-

fects this nerve either at its origin, or at the foramen through which its roots make their exit. A dislocated or diseased hip, as in the case of the anterior crural nerve, will most commonly produce more pain at or in the knee-joint than in the hip-joint. In some female disorders, the adductors become contractured and there is also pain on inner side of the thigh. This is in the form of a cramp in the average case. In hysteria, these muscles are often involved. They are sometimes injured in parturition, falls by which the limbs are abnormally separated and, Deaver says, by horseback riding. They contract in dislocation of the hip. In congenital dislocations of the hip these muscles have to be stretched to a very marked extent or else forcibly broken under anesthesia (as practiced by Lorenz) before reduction is possible. In any ordinary case of dislocation of the hip, these muscles are often affected and, in addition to the glutei, must be considered as important factors in the treatment of such a disorder. In thyroid dislocations of the hip, the head of the femur may press directly against this nerve. The author saw a case of this sort in which there was constant pain, almost excruciating, in the areas supplied by the obturator. A slight change in position would give immediate and complete relief, while pressure in the opposite direction increased the pain. This nerve may be the seat of pain referred from organs innervated by the same segment, the uterus and ovaries being at fault in most cases. The real cause may be the subluxated lumbar vertebra. Hilton says, "Tracing the trunk of the nerve we find it associated with many internal and external parts. Assuming the obturator to be the seat of pain on the inner side of the knee and within the knee-joint, it is plain that this may depend upon disease within the vertebral canal or it may depend upon some diseased condition of a vertebra near which the nerve lies. It passes over the sacro-iliac articulations, and when that joint is inflamed and swollen, as sometimes happens, patients complain of pain within the knee and on the inner side. I have known patients to complain of pain in the inner side of the knee when the disease was not in the hip-joint." He also cites cases of psoas abscess, fecal impaction of sigmoid, and other disorders of the large bowel at this point, affecting this nerve. These points entirely agree with the osteopathic explanations, since similar cases have been seen. The kinds of cases seen have been those in which the diseased condition of the vertebra near which the nerve lay, consisted of a sprain or other form of lesion of the joint, subluxation being common. The

writer had a case of synovitis of the knee-joint with marked pain and edema, which was the result of a subluxated innominate on the same side and a retrodeviated uterus. These conditions were overcome and the knee disturbances were entirely relieved.

A lesion of the third lumbar articulation will produce similar effects by pressing on the roots of origin of the obturator nerve while they are in the foramina. In cases of pain in the lower limb, it is advisable to begin at the seat of pain and examine the articulations and parts from below upward with which the nerve is in relation. In most cases the trouble will be found to be in the spine.

The **posterior division** of the third lumbar, unites with that of the first and second and help to form the superior clunii nerve. It supplies some cutaneous filaments to the gluteal region, but most of the branches are muscular. A lesion of the articulations of the third lumbar will produce contracture of the lumbar spinal muscles. These muscles are supplied with sensation by the same nerves that supply them with motion and nutrition, or at least by branches of them. The same nerve that supplies sensation to these muscles at this level does not supply the integument over the muscle. Backache, when reflex from uterine or other pelvic disorder, is, ordinarily the result of reflex contracture of the the muscles. The impulses are carried to the lumbar spinal cord by the uterine, and hypogastric nerves; the cord becomes congested, or at least abnormal impulses arise that result in contracture of muscles supplied by this segment. If the integument over the lumbar spine is tender, that is, if there is cutaneous hyperesthesia, the eleventh and twelfth thoracic nerves are most commonly involved and the trouble is uniformly a disorder of the ovary or kidney. In a reflex backache in which there is no hyperesthesia of the skin, the trouble is most commonly in the uterus and the ache is due to the congestion and contracture of the spinal muscles in that region. In the first case the explanation is that the eleventh and twelfth dorsal segments are involved, and it would not be likely that the third lumbar segment and its sensory branches would be involved, unless there were other disorders, that is disorders of viscera supplied by this segment. The ovarian plexus gets nearly all of its impulses from the lower thoracic; the uterine from the lumbar. A lesion of the third lumbar articulation may produce both contracture of the lumbar spinal muscles and uterine disease.

The **external cutaneous** nerve has been considered.

The **accessory obturator** nerve is often absent but is of importance when present, because it sends an articular branch to the hip-joint.

The **sympathetic gangliated cord** is seldom affected directly by a lesion of the third lumbar, but often indirectly. The nervi efferentes of the third lumbar ganglion consists of branches to the aortic and hypogastric plexuses. This ganglion (third lumbar) receives its motor power from the spinal cord but the route over which the impulses travel seems to be doubtful. Quain says: "White rami communicantes are not furnished by all the spinal nerves. According to Gaskell, by whose investigations the fundamental constitution of the sympathetic and its relations to the cerebro-spinal nerves were first made clear, they are found in the dog from the second dorsal to the second lumbar nerves inclusive; but Langley has shown that in the dog and cat, white rami communicantes are given off by the spinal nerves from the first dorsal to the fourth lumbar, and in the rabbit from the first dorsal to the fifth lumbar inclusive." In man it is most probable that they exist throughout the entire thoracic and lumbar regions if any reliance can be placed on clinical indications, and we will treat the subject from that viewpoint. The impulses then that pass into the third lumbar ganglion, come from the spinal cord by way of the white ramus, and in all probability, many of these efferent impulses pass on through the ganglion, with little or no interruption, into the nervi efferentes helping to form the aortic and hypogastric plexuses.

The **aortic plexus** supplies the inferior vena cava and contains nerve fibers that go to form the inferior mesenteric, hypogastric and ovarian or spermatic plexuses. The inferior mesenteric is formed almost entirely from the **left aortic plexus**. The impulses, therefore, that pass to it from the spinal cord must pass out through the foramina on the left side. On this account, a lesion in which the foramina on the left were affected, would produce bowel disorders in preference to other disturbances, assuming the impulses come from the left side, which fact seems to be borne out in clinical observations. A subluxation to the right, would affect the uterus more than the bowel. Inhibition applied to the left side of the spine of the third lumbar vertebra, will have a more marked effect on diarrhea than a similar treatment applied to the right side.

The inferior mesenteric plexus transmits, motor, vaso-motor, secre-

*Quain's Anatomy, Vol. III, pt. II, p. 359.

tory, sensory and trophic impulses to and from the spinal cord and the lower bowel. If the lesion obstructs this line of communication to such an extent that these impulses are checked or stopped, there would be, as an effect, lessened peristalsis, congestion, disturbed secretion, loss of irritability, and malnutrition of the rectum, and the descending and sigmoid colon. Constipation, hemorrhoids, ulcers and prolapsus are the most common sequellæ. If the lesion irritated these filaments, there would be increased peristalsis, anemia, secretory disturbances, secretion usually being lessened, pain, and possibly some trophic effect if the condition becomes chronic. It is seldom that a lesion will affect all of the filaments, hence only one or two of the above named functions of this plexus are usually involved by the lesion. These nerves, especially the sensory and motor, in all probability connect with the defecation center. I believe that there is a direct line of communication between the lumbar segments of the spinal cord and the bowel and that impulses pass over this line to and from the spinal cord. Also these impulses are carried over nerve filaments that pass through the lumbar intervertebral foramina. A lesion of the third lumbar articulation produces disorders of the lower bowel by affecting the size of the foramen, this interfering with the line of communication, or disturbing the nutrition of the cells from which the impulses arise.

It seems from clinical observation that few, if any, impulses pass from the third lumbar segment to the ovary. Although the ovarian plexus is derived in part from the aortic, I believe that the filaments come from a point higher up the cord. Clinically, we find the lesions which affect the ovary or testicle are several vertebræ higher, viz., the tenth, eleventh and twelfth dorsal, and sometimes the first lumbar.

The **hypogastric plexus** may be affected through the aortic, since it is formed in part by the aortic, or it may be affected by the lesion directly interfering with the impulses that pass from the spinal cord to the plexus; that is, some of the nervi efferentes of the third lumbar ganglion. From the hypogastric plexus are derived, through the pelvic, the hemorrhoidal; vesical; uterine; vaginal and prostatic plexuses. This means that nerve cells in the grey matter of the spinal cord give rise to nerve filaments that pass, with little or no interruption in the normal case, to these various plexuses, or rather through them to the viscus or organ. The sacral nerves send branches into the above named plexuses and must be considered when the effects of a lesion are to be determined.

The **hemorrhoidal plexus** supplies the rectum with vaso-motor, motor, secretory and sensory impulses. These impulses, as mentioned above, are derived from the spinal cord, pass out over the ventral root into the common nerve trunk, thence over the white ramus into the third lumbar ganglion, then over the efferent branch into the hypogastric, pelvic and hemorrhoidal plexuses. The sympathetic ganglion perhaps alters in some way these impulses, as is the function of a ganglion. A lesion of the third lumbar vertebral articulation will interfere with this line of communication. As a result there may be hemorrhoids, diarrhea, ulceration of rectum, proctitis, prolapsus or, in fact, any disease of the part that would result from an interference with the vasomotor, motor, secretory, sensory or trophic nerve supply.

The **vesical** plexus derives its impulses from the same source, in a similar way. This plexus supplies the bladder, ureter, vas deferens, vesicle seminales and testicle. From this it is readily seen that almost any disorder of these parts, may result from a lesion impairing their innervation. If the nerves to the bladder are involved, there may be retention of urine, enuresis, frequent micturition, incomplete evacuation, dribbling of urine, cystitis, calculi, pain and tenesmus. If the ureter is diseased, there may be hydronephrosis, hematuria, colic or strangury. If the nerves to the vas deferens are affected, its function is perverted, that is, the secretion of the testicle is not properly transmitted to the seminal vesicles. If some of the nerve filaments supplying these seminal vesicles are disturbed, there may be retention of the semen, passing of semen from any strain, or emissions, usually nocturnal, although they may be diurnal. If the lesion is an irritative one, the nerves supplying the receptacles of the semen are made more irritable and involuntary evacuation of their contents takes place from any exciting cause, an erotic dream being the most potent and common.

If the lesion is paralytic, that is if it inhibits these impulses, there results a condition called **spermatorrhea.** This disorder is characterized by the passing of semen in small quantities during micturition or defecation. In such cases the seminal vesicles are weak and any increase of abdominal or pelvic pressure, may overcome the resistance offered by the sphincter and a part of the contents escape. These vesicles are in relation with the rectum, and in constipation the pressure of the impaction is directly against them, this tending to cause a weakening of their walls. The straining at stool with the downward pressure also tends to cause

evacuation of the vesicle. If the part is weakened by the lesion interfering with its innervation, these causes act with greater effect. Abuses will also weaken them and should be considered in the treatment of their disorders.

The **testicle** may be affected by a lesion of the third lumbar through the vesical and pelvic plexuses but clinically the lesions are higher up the spinal column.

The **uterine** plexus is also affected by a lesion of the third lumbar. The reason for it is that the impulses supplying it come from the lumbar spinal cord and some of them pass out from the cord through the foramina in relation with this vertebra. The principal functon of this plexus is vaso-motor and motor to the uterus. It is also secretory, trophic and sensory. This has been determined from clinical observations rather than from experiments on animals. A lesion of the third lumbar may produce anemia or hyperemia or congestion. Congestion is indicated by leucorrhea, backache and sense of weight, aching of limbs, menstrual disorders and possibly catarrh or inflammation. If the motor nerves are stimulated, contraction to a painful degree is the result; if inhibited, relaxation of the muscle fibers is the sequel. On account of these motor disturbances there may be dysmenorrhea, inertia uteri, subinvolution, uterine colic and superinvolution. The secretory nerves of the uterus may be disturbed independently of the other nerve filaments, but this is the exception. The sensory nerves to the uterus may be stimulated or inhibited by the lesion, thus there may be as a consequence, pain, with increased peristalsis or numbness with lessened peristalsis. The movements, that in the peristalsis, of the uterus, like other organs that have a rhythmical movement, are controlled to a great extent by the condition of the sensory nerves, that is peristalsis is usually a reflex phenomenon.

Fibroid tumors may follow irritation to the trophic nerves to the muscle fibers of the uterus, thus causing a hypertrophy of its muscle tissue, but this I believe is unusual. Repeated congestion of the organ is probably the most important cause. The vaginal plexus also receives a few filaments from the third lumbar segment by way of the hypogastric and pelvic plexuses. I believe that most of its impulses are derived from points lower, judging from clinical indications.

The **prostatic** plexus is analogous to the uterine and is formed from filaments from the same source. The impulses pass out over the ventral

root, white ramus, third lumbar ganglion, hypogastric plexus and pelvic plexus. They are vaso-motor, motor, sensory, secretory, and possibly trophic. The vaso-motor effect is that of constriction or dilatation of the blood-vessels. Constriction results in anemia, dilatation in congestion. Congestion increases the secretion of the prostate and often produces prostatorrhea. This condition is often confused with spermatorrhea. A mucus discharge during defecation or at the completion of the act of micturition, is most commonly prostatorrhea. Congestion may produce reflex effects similar in character to those from uterine congestion, viz., backache and headache. There seems to be an increase in the temperature of the integument of the top of the head in such cases, this possibly having something to do with alopecia, the increased temperature tending to dry the roots of the hair in relation. The gland is more of a muscle than a gland and its function is to expel by its contraction, what urine may in be the lower part of the bladder and urethra and during orgasm, the semen. If the muscle fibers are weakened, micturition is imperfect and often there is no orgasm. If weakened by a lesion inhibiting its motor nerve supply, this function is impaired in proportion to the degree of disturbance; marked weakness of this gland accompanies some forms of impotence. If the lesion is irritative, the patient experiences pain in micturition, and micturition is established only after several moments of straining. This is also characteristic of hypertrophy from any cause but is especially marked in enlargement from excessive venery or specific urethritis that has extended beyond the triangular ligament, to the prostate. The sensory effects are usually indicated by frequent micturition. The secretory nerves may also be impaired by the lesion, there being a lessened or increased amount of secretion. These various effects are determined more by the amount of venery than by any one thing else. Abuse of the organ plus a lesion, will in every case produce some or all of the conditions named above, hypertrophy being the most important on account of its frequency.

A lesion of the third lumbar articulation affects the prostate (1) by breaking or otherwise impairing the line of communication between the third lumbar segment and the gland; and (2) by interfering with the nutrition of the nerve cells that give rise to and control the impulses that pass to the gland. The lesion usually does one of the above by direct pressure on (1) the nerve trunk which contains the nerve filaments mentioned above, or (2) by direct pressure on the blood-vessels that supply or drain the third lumbar segment.

The **recurrent meningeal** nerve is affected in a way similar to that of the recurrent nerves mentioned above, and the effect of the interference with its function is about the same.

The **gangliated cord** itself may be affected directly by the lesion through tightening of the tissues or enlargement of viscera, thus causing pressure on it. It is so located in this region that an enlarged viscus may produce direct pressure on it, if the patient is in the dorsal posture. In four footed animals, nature has so arranged that the gangliated cord and its branches and connections, the spinal blood-vessels and the azygi and lumbar veins, are free from pressure on account of posture. This should serve as a hint as to the cause of certain diseases characterized or accompanied by disturbances of these structures, also the treatment for them. Pressure on the sympathetic cord will produce effects in viscera and structures supplied with nerve force by way of this cord. At the third lumbar, the pelvic viscera and the lower bowel are most involved.

The effect on the **spinal cord** or cauda equina, like most other effects, varies with the degree of the lesion and the condition of it. If the subluxation is so marked that pressure is exerted on the cauda equina at this point, degeneration with paraplegia follows. In such cases the paralysis affects the lower limbs, bowel, bladder and, to a certain extent, the pelvic viscera. The limbs undergo atrophy and are cold even in warm weather. Deformities sometimes develop. In the case of the bladder, there is a dripping of urine on account of paralysis of the vesical sphincter. The bowels are paralyzed to such an extent that there is constipation in an aggravated form. The sexual organs are commonly involved, impotence being an effect. The circulation to this part of the cord is also affected.

The **spinal column** is weakened at the point of lesion. In some instances it may only be a "crick" in the back, or in others the patient may be prostrated. Curvature develops in some, caries of the vertebræ in others. In every case of a true lesion of the third lumbar articulation, the articular facets are not in perfect apposition so that the function of the joint is disturbed in proportion to the degree of displacement and effects on the attached tissues, principally the ligaments. In some cases an apparent anchylosis develops and nature compensates for this loss of motion by increasing mobility at some other point, usually at the articulation between the thoracic and lumbar regions.

A lesion of the third lumbar is most frequently associated with lumbago, backache, disorders of the lower bowel, pelvic organs and disturbances of the lower limb, principally motor and sensory.

THE FOURTH LUMBAR.

The **fourth lumbar** vertebra is slightly larger than the third. The body is distinctly reniform in shape. The transverse processes are frequently very much elongated while in other cases, they are rudimentary. They give attachment to the ilio-lumbar ligaments which are in turn affected in practically all subluxations of the vertebra. The spinous process is heavy and in old and muscular subjects, there are often found facets for articulation with the process above and below. The intervertebral **disc** is very thick and markedly elastic, yet on account of its position, it bearing the superimposed weight of the body, it is often flattened and non-elastic. There is quite pronounced movement of its articulations which is lessened as the patient becomes older, in sedentary occupations and in cases in which there are lesions in this region. The lesions of the articulations of this vertebra are common, most of them coming from sprains of the back. It is decidedly unusual for a complete dislocation to occur at the articulations of the fourth lumbar on account of the depth of its articular facets and the strength of the spinal ligaments. Sprains of the spine often occur at this point on account of its position, it being a point at which the strain is very great as in lifting, or in any muscular effort in which the spinal column is used. An unexpected torsion, a mis-step, extreme flexion, rotation or extension will cause a rupture of some of the fibers composing the spinal ligaments. A sprain results if the movement of the articulation is beyond the physiological range. Every articulation has a certain definite range of movement and the ligaments of the joint limit this movement. A sudden or forceful twist whereby the movement is abnormal in extent, partly dislocates the articular surfaces and injuries the ligament. This causes an irritation, tenderness, a thickening, lessened movement and the usual symptoms and signs of a lesion or subluxation of the vertebra. Most of these sprains or lesions come from torsion or extreme flexion, hence the deviation of the vertebra which is judged, to a great extent by the position of the spinous process, is to one side or posterior.

These lesions produce varied effects on adjacent and distant structures. In acute or recent cases, the local effect is the most pronounced,

but in chronic cases, the secondary or distant effect is most marked. These effects may be motor, sensory, vaso-motor, secretory, or trophic, depending on the degree of the lesion and the kind of nerve filaments and number of blood-vessels affected by the lesion. Since the fourth lumbar foramen is formed in part by the ilio-lumbar ligament, it follows that any subluxation of the fourth lumbar vertebra, would affect the size of this foramen if this ligament were injured, which is the condition in the average case.

The **motor effect** may be that of a weakening or relaxation; contracture or hypertonicity. The **muscles** on the inner and anterior aspect of the thigh may be involved by a lesion of the fourth lumbar. If the lesion is paralytic, relaxation with weakness of the muscles in this area is the result. Locomotion is interfered with since the patient with difficulty, if at all, is able to lift the limb, that is flex the thigh, thus the patient to overcome this, leans forward to carry the line of gravity beyond the base. Spastic paraplegia furnishes a type of such disorder. If the adductors are relaxed and weakened, adduction is impaired in proportion to the degree of relaxation. This is not a common effect. If the lesion is irritative the thigh is flexed on the abdomen,and adducted. Straightening of the limbs and abduction are impossible or very painful and hard to perform. Deformities of the lower limbs sometimes result. In some cases there are spasms of these groups of muscles. Continued contraction produces pain, sometimes a cramping of the muscles of the thigh. The sartorius muscle, by its contraction, interferes with the venous drainage of the limbs and varicosities result from the obstruction thus caused. It crosses the thigh immediately below the saphenous opening and its contraction if prolonged, obstructs to a certain extent, the lumen of the veins in relation. These effects on the muscles result from inhibition or stimulation of the anterior crural and obturator nerves. These nerves have part of their origin in the fourth lumbar segment, and the roots originating in the fourth lumbar, form a part of the cauda equina and pass out at the fourth lumbar intervertebral foramen. This foramen or the one between the third and fourth lumbar, is always lessened by a subluxation of the fourth lumbar, hence the effect on these nerves.

Most contractures, I believe, result from disturbances of the vascular supply of the cells in the spinal cord. These cells are located in the anterior horns of the grey matter and control the tone of muscles innervated by the nerve filaments having their origin in these cells. A stimulation of the cells would result in hypertonicity.

The gluteus medius and minimus are innervated by this segment. If their nerves are inhibited, adduction of the hip-joint, rotation of the thigh inwards and approximation of crest of ilium and great trochanter, are difficult or impossible. Morris says: "In walking, if it were not for the powerful contraction of the gluteus medius and its associated muscles, the gluteus minimus and tensor vaginæ femoris, the pelvis would not be held firmly upon the upper part of the thigh when one leg is upon the ground and the other is advanced in the forward step. In fast walking the rotatory action of the muscle comes into play, for not only does the gluteus medius, of the limb which is resting upon the ground support the pelvis by drawing downward the crest of the ilium, but, by drawing backward the front portion of that crest, it throws forward the opposite side of the pelvis and increases the length of the stride." A lesion of the fourth lumbar, will impair these movements since it disturbs the nerves innervating the above named muscles. This lesion will also affect the **quadratus femoris** muscle. This muscle is a strong external rotator of the femur, which function would be perverted by the lesion. Some of the muscles of the back of the leg are innervated by the fourth lumbar segment, also those of the front and outer side of the leg. Impairment of these muscles may be directly due to the lumbar lesion. Contracture, as in cramping of the muscle, is not unusual, while weakness is quite common. Infantile paralysis and its effects on muscles will be considered under trophic effects of this lesion.

The muscles of the back supplied by the posterior division of the fourth lumbar nerve are also relaxed, or more commonly, contractured, as a result of the lesion. A relaxation usually means hypermobility with pronounced weakness of the spine at this point. A curvature results in approximation of the vertebræ, impairment of circulation through the muscle and the spinal cord, stiffness of spine, hence lessened mobility, tenderness in and over the muscles, and later on, deformities of the spinal column, that is, curvatures. These muscles, the multifidus, erector and rotatores spinæ, are connected by filaments with nerve cells in the fourth lumbar segment. A lesion of the fourth lumbar articulation interferes with this line of communication, hence the effect. It does little, if any good, to treat the effect, that is to try to relax or contract the muscles by direct manipulation of them, unless there is structural shortening, since their condition is the effect. Adjust the vertebra and the effect will disappear.

The **uterus** and **Fallopian** tubes, especially the former, are supplied with motor impulses by way of the uterine and ovarian plexuses of nerves. These motor impulses in all probability, come almost entirely from the spinal cord, although some may be derived entirely from the sympathetic gangliated cord. In the grey matter of the fourth lumbar, as well as in the segments above it, are located cells that control and give rise to motor impulses that pass to the uterus, principally by way of the ventral root of the fourth lumbar nerve, common trunk of this nerve, ramus communicans to the gangliated cord, then by way of the nervus efferens, to the hypogastric and uterine plexuses. These impulses, like others, may be inhibited or stimulated. If inhibited, the uterine muscle fibers relax. The size of the uterine blood-vessels is controlled to a great extent, by the condition of the muscle fibers of the uterus; that is, a certain amount of tone or contraction is necessary to the proper functioning of the blood-vessels. As a result of this relaxation the blood-vessels enlarge and congestion immediately occurs. **Parturition and menstruation are difficult on account of this muscular weakening.** If the motor impulses of the uterus are stimulated, the uterine muscle fibers contract, often to a painful degree as is illustrated by some forms of dysmenorrhea and post-menstrual pain. Even after the menstrual flow has been entirely expelled, this irritation from the lesion continues and uterine contractions continue, hence the pain. The menstrual flow is usually scant, since the contraction of the uterus lessens the amount of blood in the uterus.

The peristalsis of the **Fallopian tube** is lessened by a lesion that inhibits the impulses, while it is increased to a painful degree, in cases in which the lesion is irritative.

Some of the motor impulses to the **vagina** may pass from the spinal cord (fourth lumbar segment) by way of the hypogastric, pelvic and vaginal plexuses, but I believe that most, if not all of them come from the sacral segments. A few cases of motor disturbances of the vagina have come under my care in which the lesions were undoubtedly in the lumbar area. The vaginal walls become relaxed if the motor impulses are shut off or even inhibited. This results in a large, patulous vagina with obliteration of the rugæ. If the motor impulses are increased in number or intensity, the muscle fibers of the vaginal walls contract. Vaginismus is the best example of this effect.

In the male, the muscle fibers of the **prostate** may be affected by a

lesion of the fourth lumbar in a way similar to that from a lesion of the third lumbar, which has been considered above.

The **vas deferens** is supplied with motor impulses by the fourth lumbar segment. Landois in speaking of ejaculation says, "The center (Budge's genito-spinal center) is situated at the level of the fourth lumbar vertebra in rabbits. The motor fibers of the vasa deferentia are derived from the fourth and fifth lumbar nerves which enter the sympathetic and finally pass thence to the vasa deferentia." From clinical observation in man it seems that the center is the same as that mentioned above, viz., fourth and fifth lumbar. The peristalsis of the vas deferens is affected by a lesion of the fourth lumbar. The functions of this vessel are to convey the secretion of the testicle to the seminal vesicles and to assist in ejaculation. These functions are impaired, because the peristalsis is decreased or increased to a pathological degree.

The **seminal vesicles** are also affected by a lesion of the fourth lumbar.

The **rectum** and **lower bowel** are often affected by a lesion of the fourth lumbar. The effect is due rather to a disturbance of the secretory, sensory, vaso-motor and motor, than to a disturbance merely of the motor nerve. This lesion is most often found in diarrhea. It may stimulate the motor nerve thereby increasing the peristalsis, or it may affect the secretory, vaso-motor or sensory impulses. Peristalsis of the lower bowel is governed by motor impulses from the lumbar spinal cord, the fourth lumbar segment being very important. If the lesion is irritative, peristalsis will be increased; if inhibitive it will be lessened. Inhibition applied to the fourth lumbar vertebra, or a great deal better still, a correction of the subluxations in the lumbar region, will relieve and cure flux and kindred disorders in practically all curable cases. The explanation is that the lesion irritates the motor or other nerves to the bowel and by correcting the displacement or subluxation of the bone, this irritative effect is lessened or entirely relieved. The nerves carrying these impulses are the hypogastric, pelvic and hemorrhoidal plexuses. If the lesion inhibits the impulses, constipation with relaxation of the muscle fibers in the lower bowel will result.

The **bladder** may also be affected by the lesion. The effects are similar to those from other lumbar lesions and have been considered.

A lesion of the fourth lumbar may produce sensory disturbances in the skin of the lower limb, muscles innervated by the fourth lumbar seg-

ment, the pelvic viscera and certain articulations. The **cutaneous effects** of a lesion of the fourth lumbar articulation are manifested by pain or anesthesia, partial or complete, in the integument on the anterior portion of the thigh, inner and outer sides of the leg, inner side of foot and over a part of the gluteal region. If the lesion is irritative, there will be pain; if inhibitive, numbness. Many a pain in the lower limbs is due to a lumbar lesion. The explanation is that the anterior crural and obturator nerve sand lumbo-sacral cord, supply the limb with sensory impulses, or rather the sensory or efferent impulses from the lower limb pass through these nerves. These nerves are more or less involved by a lesion of the fourth lumbar, because some of their roots pass through the intervertebral foramina in relation with the fourth lumbar articulation.

The **muscles** supplied with motion by the anterior crural, obturator, anterior tibial and posterior division of the fourth lumbar nerve, are also supplied with **sensation** by the same nerves. The lesion may produce a numbness in them but more commonly a pain or ache. **This painful condition simulates what is ordinarily called muscular rheumatism and is often confused with it.** The sensory innervation of a muscle is not nearly so great as the cutaneous nerve supply, since sensory nerves principally **supply the superficial structures to better insure protection of the organism.** Aching of the limbs is often due to a lumbar lesion. This lesion irritates the sensory filaments of the nerves passing through the fourth lumbar segment and the impulses resulting, are referred by the sensorium to the limb, the supposed source. In acute pain in the muscles of the legs, the trouble is nearly always in the spine; in aches of the lower limb the cause may be in the spine or it may be the result of impure blood in the muscle itself. In cases of unusual activity of a muscle, there is excessive katabolism and this acts as a chemical irritation to the sensory nerves supplying the muscle. In back-ache in the lower lumbar region, the cause may be in the spine, which condition directly stimulates the nerve supply of the spinal muscles, this producing contracture. Often the lesion affects the viscus, which disturbance in turn causes reflex contracture of the spinal muscles, and nearly all contractured muscles are tender and subject to ache. Aching of the lower lumbar region is indicative of (1) lesion of the lower lumbar or (2) pelvic disorder of the uterus in the female, and prostatic disorder in the male.

According to Head's chart no viscera are supplied with sensation by the fourth lumbar segment, but clinically there are indications that this

segment controls in part, the sensory innervation of the bowel, bladder and pelvic genitalia. The writer has had many opportunities to test this in cases of pain in these organs, and has often found that a slight twist of the fourth lumbar vertebra produces pain in the above mentioned parts and that a correction of the lesion brings relief.

The fourth lumbar segment controls the sensory nerves supplying the hip-, knee- and ankle-joints, the sacro-iliac synchondrosis and perhaps the articulations of the foot. Pain in the hip-joint is often due to a lesion of the fourth lumbar articulation since it will irritate the anterior crural and obturator nerves, both of which send filaments to the hip-joint. The impulses arising from this irritation are carried by the same pathway that those from the hip-joint pass and the sensorium is mistaken as to their source. This lesion produces symptoms that are often mistaken for those from injury to or dislocation of the hip, knee, ankle or innominate. In painful conditions of the knee-joint, the cause is often in the spine. Most cases of pain in the knee-joint are due to disease or dislocation of the femur, but occasionally the lumbar region is responsible.

Pain in the lower limb, lower bowel, and generative organs, is often the result of a lumbar lesion, and a lesion of the fourth lumbar articulation is the most important one of the lumbar lesions.

The **blood-vessels** innervated by the fourth lumbar segment and the lumbar gangliated cord are more or less disturbed by this lesion. They are either lessened or increased in size, the first producing anemia, the second, congestion. The **cutaneous blood-vessels** are often disturbed. This disturbance may be indicated by coldness of the part or a congestion, this increasing the surface temperature and changing the color to a vivid pink or it may be mottled. The areas involved are the gluteal, and part of the thigh. The cutaneous circulation through these areas is poor in comparison to that of other areas of the body, hence the frequency of boils on the buttocks and the lowered temperature which is so common. These blood-vessels are supplied with vaso-motor impulses derived from the fourth lumbar ganglion; some probably coming from the segment, they passing out over the ventral root, common nerve and posterior division of the fourth lumbar nerve. The spinal blood-vessels are affected by this lesion since they are innervated by the fourth lumbar segment by way of the recurrent meningeal nerve. The effects of a lesion on this nerve have been considered.

The **pelvic blood-vessels** are affected by this lesion through a disturbance of the hypogastric and pelvic plexuses with their branches and communications. The blood-vessels most affected are the uterine and hemorrhoidal. Anemia or congestion may follow, it depending on whether the vaso-motor nerves are stimulated or inhibited by the lesion.

The vessels of the lower limb are also affected by the lesion through

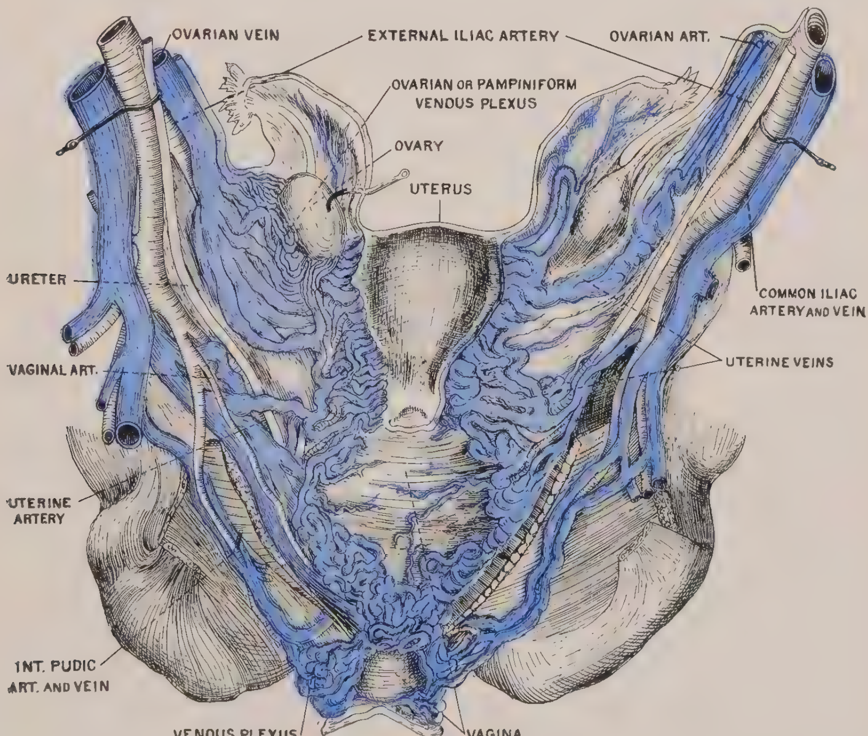

FIG. 67.—Showing the veins of the female pelvic organs. Note their number and tortuosity. Displacements of the uterus or enteroptosis readily obstruct these veins and thus lead to congestion (after Spalteholz).

disturbance of the crural nerve and the plexus around the iliac arteries. These plexuses are formed by branches from the spinal cord. Anemia of the limb results if the blood-vessels are constricted; congestion, if they become dilated. **Varicose veins** sometimes result from a lesion of the fourth lumbar, because it inhibits the passing of impulses to the

veins of the limb. There is usually some exciting cause which further dilates the veins, such as standing on the feet for long periods, enteroptosis or pelvic enlargements. The primary and predisposing causes are in the spinal column. All parts below the occiput must connect with the spinal cord if it is to functionate properly. The moment this connection is broken, the function of the part is affected and soon it becomes the prey of disease. Nature has arranged for compensation if the in-

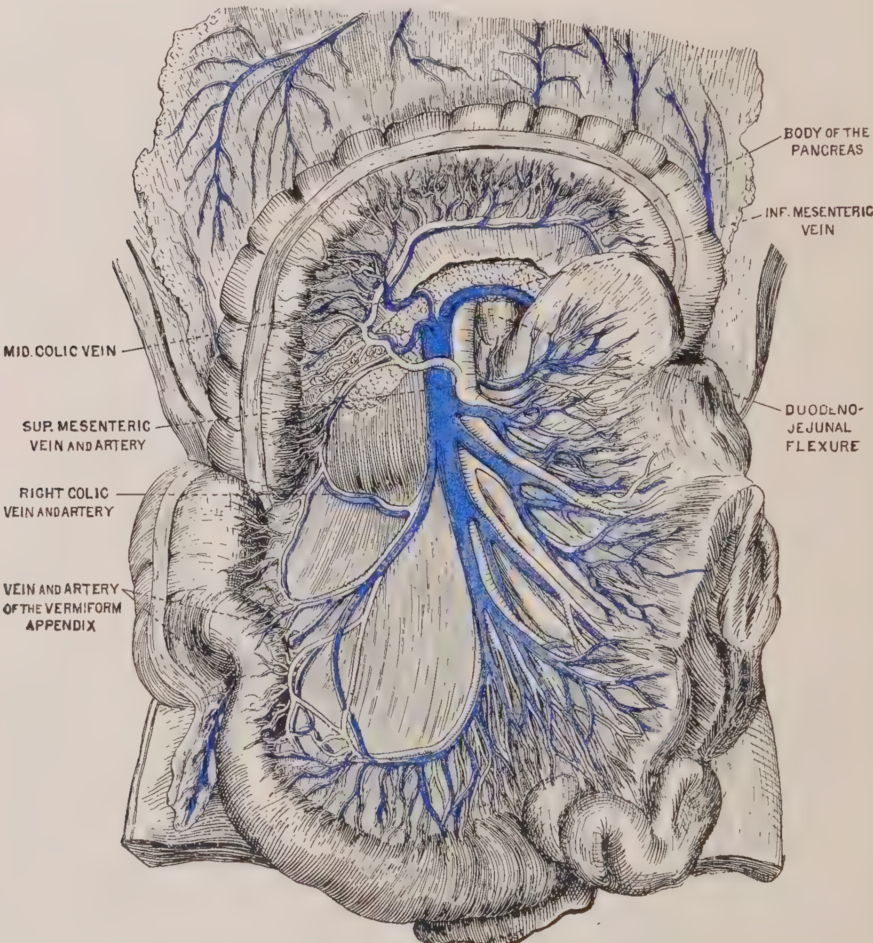

Fig. 68.—Showing the veins of the intestines.

jury is not too great; that is impulses may pass over other nerves in relation and connected with, the affected part. A lesion of the fourth lumbar, breaks the connection existing between the spinal cord and the blood-vessels of the lower limb. At first the circulation through the limb is slowed; this is accompanied by aching of the limb, or it may become cold. If only the superficial vessels are affected, varicosities result. The explanation is that the vaso-motor impulses to these vessels pass out from the spinal cord over nerve filaments that pass through the intervertebral foramina in relation with the fourth lumbar, and in lesions of this articulation, the foramen is always lessened in size from change in position of the bone or by deposits from injury to ligaments.

Secretory disorders resulting from a lesion of the fourth lumbar are most commonly indicated by catarrh of bowel, uterus and bladder and excessive perspiration of lower limbs. These disorders, particularly the catarrhal ones, are due to a great extent, to the vaso-motor disturbances but in addition the secretory nerves are also involved, this making the effect more marked. Lack of sweat or excessive perspiration of the lower limbs is sometimes encountered and can be traced to spinal lesions, the fourth lumbar being an important one.

The **trophic** disorders are most marked in the lower limb and consist of malnutrition with atrophy. The nutrition of a part depends on amount and character of the blood supply and ability of the part to select from this blood, food that is nourishing. The trophic nerve is supposed to be a separate nerve filament which has the function of controlling this selective process. The trophic nerve cells are in the anterior horns of the grey matter of the spinal cord. Like other cells, these must have nerve filaments connecting them with the parts innervated. If this line of communication is broken or impaired, the part suffers, or if the cells are affected, a similar result follows. **Infantile paralysis** is a type in which the trophic cells are impaired or destroyed. If destroyed, the paralysis resulting from it is incurable; but if their function is only suspended a cure may be effected. It is advisable to treat the case for a while in order to ascertain which kind it is, since the diagnosis can not very well be made in any other way. The lesion is responsible for many cases of both forms because it disturbs the nutrition of the nerve cells or produces a congestion so severe that hemorrhage results.

The **hip-joint** is especially affected in lesions of the fourth lumbar, which disturb the nutrition of the lower limb. As a result, the ligaments

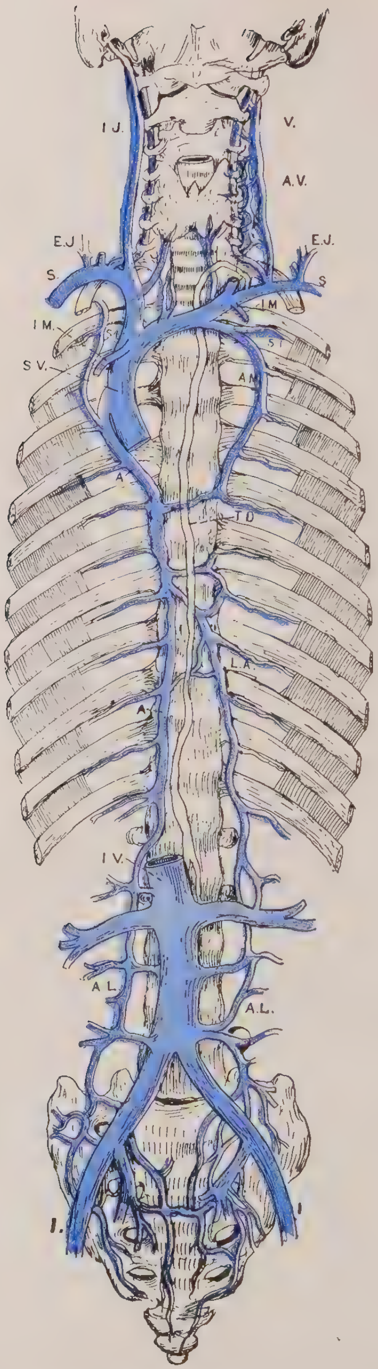

Fig. 69.—Showing the azygi veins and their tributaries. I. J., internal jugular; E. J., external jugular; S., subclavian; S. V., superior vena cava; A., azygos major; I. V., inferior vena cava; A. L., anterior lumbar; I., iliac; L. A., left lower azygos; V., vertebral; A. V., anterior vertebral.

become stretched and weakened, permitting the head of the bone to drop part way out of the acetabulum. This is especially true of anterior polio-myelitis and has given rise to many errors in diagnosis, as the condition resembles a dislocated femur. In congenital dislocations, the lack of development of the acetabulum and leg can be overcome to a marked extent, by spinal treatment applied at or near the fourth lumbar. In most cases of dislocated hip, some form of spinal lesion is present, the correction of which constitutes a preliminary treatment prior to the reduction of the dislocation. In hip-joint disease, the predisposing cause is the spinal lesion which interferes with the nutrition of the hip-joint, then the trauma or dislocation the more readily results in disease. If the vitality is lowered to a certain degree, the tubercle bacilli if present, become active and tuberculosis of the hip is the result. Most, if not all, of these trophic impulses that supply the hip-joint pass by way of the obturator, sciatic and anterior crural nerves, therefore a lesion of the fourth lumbar would interrupt the passing of these impulses, hence the malnutrition from the spinal lesion.

The **spinal column** itself is also affected by this lesion through the trophic nerves. The spinal ligaments are relaxed, the spine weakened, the vertebræ abnormally separated on movement of the body. In chlorosis, the spine is often affected in this way and secondary spinal lesions are common. The **vertebræ** also receive trophic impulses from the fourth lumbar segment by way of the recurrent nerve. Caries with psoas abscess, will often follow when the trophic nerve to the vertebra is impaired. The ligaments of the sacro-iliac synchondrosis receive some trophic impulses from the obturator nerve. A weakness of this joint will follow a lesion of the fourth lumbar if this particular function of the nerve is impaired thereby.

There are certain **centers** located in this portion of the spinal cord. The center for erection is located in part, in this segment. Landois says: "The centripetal fibers are the sensory nerves of the penis. The centrifugal fibers are for the deep artery of the penis, the vaso-dilator nerves from the first, second and third sacral nerves, (Eckhard's erector nerves) for the ischiocavernosus and the deep transverse perineal muscle, the motor fibers from the third and fourth sacral nerves." The lesion may inhibit this center, thus making erection imperfect or impossible. This form of impotence is not unusual and is the result usually of two causes, (1) a lesion which inhibits the activity of the center and (2),

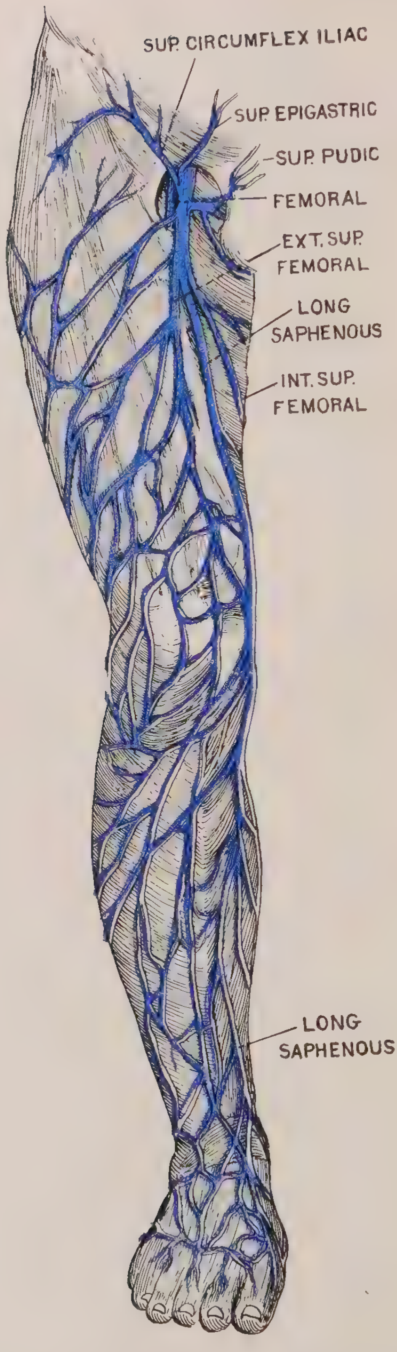

Fig. 70.—Showing the superficial veins of the lower extremity. Note the relation to the saphenous opening and that contracture of the tissues would obstruct the drainage of the limb

abuses of the part. Taylor speaks of the fourth lumbar as the sexual center. Stimulation at the fourth lumbar or the sensory nerves (posterior division) supplying the buttocks will excite this center. If the lesion is an irritative one, frequent erection takes place. The probable explanation is that the lesion produces a congestion of the center. Sleeping on the back with an impacted bowel also produces a congestion of the spinal cord followed by erection and nocturnal emission.

The center for ejaculation is also located in this segment. Landois says, "Ejaculation may be induced by mechanical stimulation of the lumbar cord in guinea pigs." In man, a lesion of the fourth lumbar articulation acts as a mechanical stimulation of this center and consequently emission takes place from any exciting cause. This, like other centers, may be inhibited or stimulated by a lesion. If inhibited, ejaculation is impossible or imperfect; if stimulated, it is frequent and takes place from trivial causes. Congestion of this part of the cord from other causes is also an important thing to be considered in such cases. Sleeping in the dorsal posture produces hypostatic congestion of this part.

The disorders most commonly caused by a lesion at the fourth lumbar are flux, diarrhea, constipation; fibroid tumors of uterus, congestion and inflammation of the uterus; sexual disorders, such as impotence, nocturnal emissions, satyriasis; disturbances of the lower limbs and their articulations, such as pain, atrophy, varicose veins, and inflammation. The lesion produces disorders by lessening the size of the intervertebral foramina, thereby producing pressure on (1) nerves that pass through, and (2) blood-vessels that are in the foramina, thus affecting the drainage and nutrition of the spinal nerve cells.

THE FIFTH LUMBAR.

The **fifth lumbar** vertebra, in an osteopathic way, is one of the most important on account of the frequency of its subluxations. This vertebra is characterized by a very large body which is thicker in front than along its posterior border. This produces in part, the anterior curve of the lumbar spine which is most marked at the fifth. Also the lower surface of the body seems to be cut away in order to secure better articulation with the upper part of the sacrum. The transverse processes are heavier and longer than those of the fourth lumbar, giving better attachment to the lumbo-sacral ligaments. The superior facets face inward, the inferior forward and outward and are considerably wider apart

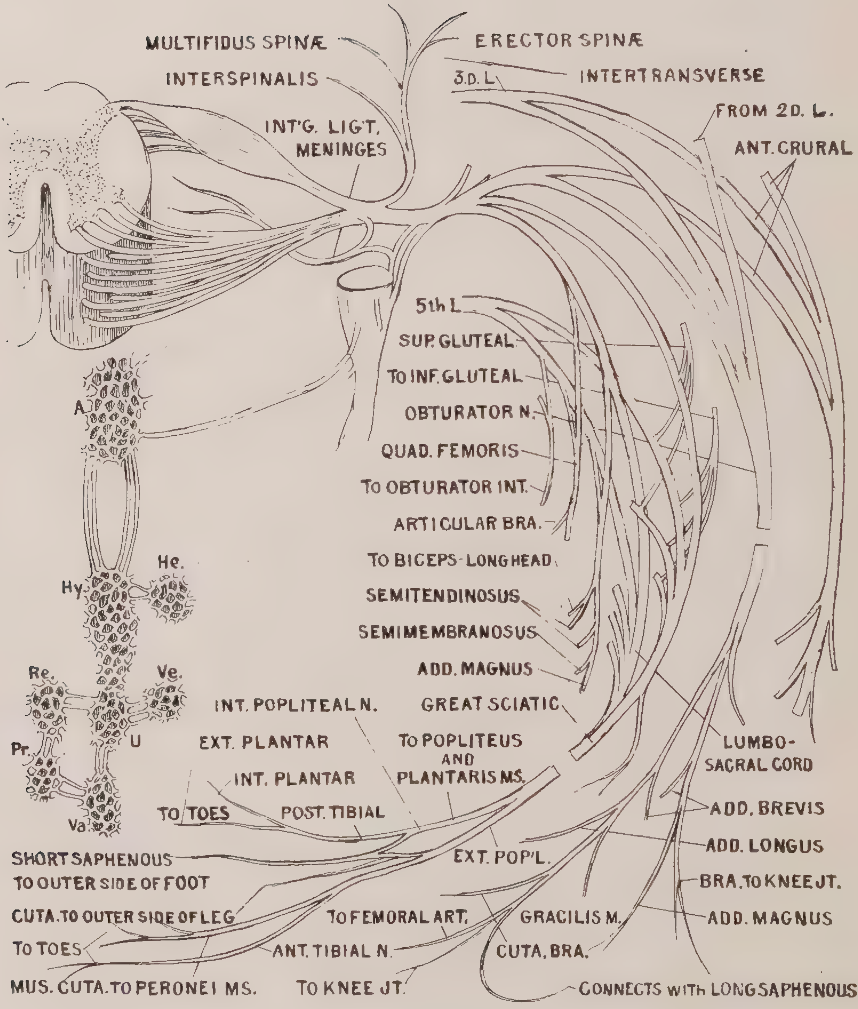

FIG. 71—The tourth lumbar segment of the spinal cord, with its nerves and their distribution.

than the corresponding facets above. The spinous process is usually smaller and situated more anteriorly than that of the fourth. The intervertebral disc below is quite thick and is the largest of all. The vertebra is located considerably anterior to the other lumbar vertebræ, which fact may account for the frequency of its forward displacement.

The **movements** of this part of the spine are normally, well marked. The antero-posterior movements are most marked and possibly on this account, anterior and posterior displacements are most common. The articulation between the fifth lumbar and sacrum is a weak point in the spinal column on account of the fact that a comparatively movable part articulates with an immovable part, the sacrum. This is also true of the dorso-lumbar articulation.

The **lesions,** or subluxations, are similar in character to those of the lumbar vertebræ above; that is it may be anterior, posterior, or there may be torsion. The posterior subluxation is caused by extreme flexion with a strain, as in lifting in the stooping posture. It produces little trouble in comparison with an anterior deviation of the same degree. The spinous process is prominent and the distance between it and the first sacral spine is increased, that is there appears to be a break or separation at this articulation. The anterior subluxation is more important than the posterior because it produces a greater effect on the intervertebral foramina, that is it lessens their size.

In addition to the usual spinal ligaments there are two special or accessory ligaments, the **ilio-lumbar** and the **lumbo-sacral,** which help to more securely bind the fifth lumbar to the sacrum. This apparent precaution against dislocation is taken, on account of the strain to which this (lumbo-sacral) articulation is subjected.

The **lumbo-sacral** ligament is very strong and is intimately blended with the ilio-lumbar ligament. It is triangular below and blends with the periosteum lining the base of the sacrum and the iliac fossa. The internal and inferior border or edge, helps to form the foramen between the fifth lumbar and sacrum, through which the last lumbar nerve passes. The effect of an injury to this ligament on this nerve can be appreciated the better on account of this foramen and its relation to the nerves.

The fibers of the **ilio-lumbar** ligament are about horizontal and attach the ilium to the transverse process of the fifth lumbar and pedicle and transverse process of the fourth lumbar vertebra. It is also triangular in shape but with the base attached to the vertebra instead of

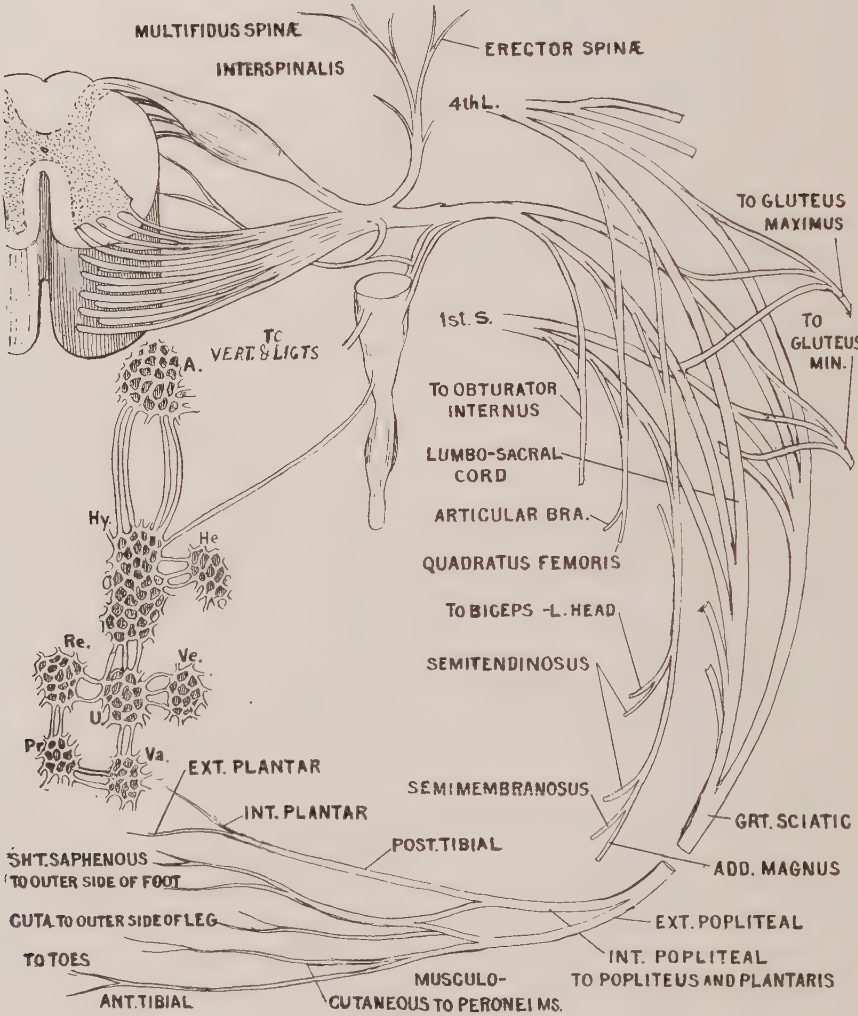

FIG. 72.—The fifth lumbar segment of the spinal cord, with its nerves and their distribution.

the innominate. The fourth lumbar foramen is partly formed by it. This ligament helps to form the posterior boundary of the true pelvis, reinforces the sacro-iliac ligaments and in part, furnishes origin to the multifidus spinæ and quadratus lumborum muscles. The sacro-lumbar and ilio-lumbar ligaments are supplied with blood by the arteries in relation, the last lumbar, lateral sacral and ilio-lumbar arteries. Their nerve supply is from the recurrent meningeal of the fifth lumbar and twigs from the fourth and fifth lumbar nerves. Many a case of lumbago results from a sprain of one of these ligaments. The movements of the joints in relation are impaired, that is there is a stiffening of the joint or hypermobility and the articulations are weakened. In cases in which the lumbo-sacral articulation is injured, that is if there is a lesion at this joint in addition to the injury to the tissues attached, the foramen formed by the fifth lumbar and sacrum is changed as to size, usually lessened. If it is increased, the foramen between the fifth and fourth is lessened, thus a lesion of the fifth lumbar articulation results in a lessening in size of the foramina. The foramen below the fifth conveys blood- and lymph-vessels and nerves. The effect on the vessels of a lessening of the size of the foramen is similar to that described under the various other vertebræ.

The **nerves** affected, that is those represented by filaments that pass through the foramen, are the posterior division of the fifth lumbar, superior gluteal, inferior gluteal, muscular to the quadratus femoris, obturator internus, erector and multifidus spinæ muscles, the great sciatic and its branches, aortic plexus (perhaps only a few filaments) hypogastric plexus, recurrent meningeal and twigs to the vertebræ and ligaments. The malposition of the joint either exerts a stimulating or inhibitory influence on these nerve strands.

The **posterior division** of the fifth lumbar nerve sends a filament to the first sacral nerve and assists in the formation of the middle clunii nerves. The internal division ends in the multifidus spinæ muscle, while the external becomes cutaneous by piercing the gluteus maximus muscle. If the lesion causes a stimulation of this nerve, the posterior division of the fifth lumbar, there would be pain over the lower gluteal region and contraction of the multifidus spinæ muscle. The result of the contraction is an approximation of the lumbar vertebræ or a scoliosis toward the affected side, and the movements of the spine wherein this muscle is used become difficult, the condition being commonly called

lumbago or muscular rheumatism. This nerve is often the seat of pain referred from pelvic disorders. The anterior division innervates some of the pelvic viscera and when irritated, the pain is referred to the more highly sensitive part, the posterior division. The converse is possibly true; that is, a stimulation of the posterior division will cause a stimulation of the anterior division. If the lesion produces an inhibitory effect there is numbness or anesthesia in the above named parts with relaxation of the multifidus spinæ muscle.

The **superior gluteal** nerve is motor to the gluteus medius and minimus. The function of these muscles has been given. If the nerve is **stimulated**, contraction of these muscles follows, which soon develops into a contracture. Movements of the lower limbs are difficult and adduction and abduction of the hip are restricted. If the superior gluteal nerve is **inhibited** by the lesion, relaxation with atrophy of the muscles follows. This nerve is formed from several segments but the lumbosacral cord gives origin to the greater part of the nerve, and the impulses are carried from center to periphery by nerve filaments that pass through the fifth lumbar foramen, hence would be subject to injury in subluxations of the fifth lumbar or sacrum.

The **inferior gluteal** supplies the gluteus maximus. The function of this muscle is to produce powerful and forced extension of the hip as in ascending a stairway, running and jumping. It is an extensor of the pelvis when the fixed point is below, as in rising from a stooping posture, and is also called the muscle of copulation by some writers. If the lesion interrupts the transmission of the nerve impulses to this muscle, extension of the hip-joint is weakened in proportion to the degree of interference, and movements of the body in which this muscle is used, as pointed out above, become labored or impossible. The opposite effects occur if the inferior gluteal nerve is stimulated, that is extension is exaggerated, and flexion both of the hip and pelvis, is opposed by these glutei muscles, hence is slow and difficult.

The **nerve to the quadratus femoris,** controls the nutrition and activity or function of this muscle. This muscle is a powerful external rotator of the femur. In case of inability to externally rotate the femur or in cases in which external rotation is extreme, this nerve may be at fault. The same is true of the obturator internus. Supposed rheuma tism of the hip and limb and stiffness of the hip-joint are due, in many cases, to contractured conditions of the above named muscles, caused

by a lesion at the fifth lumbar which affects the nerves innervating them.

The **great sciatic nerve,** the largest nerve in the body, is partly formed by the fifth lumbar segment and is more or less disturbed as to function by a lesion of the fifth lumbar vertebra; one of its roots passes through the fifth lumbar foramen and one through the fourth lumbar foramen, both of which are in relation with these articulations. These roots are compressed partly or completely by the malposed vertebra, and, although the other roots may partly take on the function of those disabled by the lesion, there will be some effect. These roots, like others, may be stimulated or inhibited by the lesion and since so many nerve filaments compose them, the effect may be localized or quite widely distributed, which conditions are well illustrated by a condition called Morton's toe, and general atrophy of one leg. This nerve "supplies the muscles at the back of the thigh, and by its branches continued from it, gives nerves to all the muscles below the knee and to the greater part of the integument of the leg and foot. The several joints of the lower limb receive filaments from it and its branches." In short, it supplies the above parts with motor, sensory, secretory, vaso-motor and trophic impulses. As a result, a lesion of the fifth lumbar may produce motor paralysis or spasticity, anesthesia, or some form of it, or hyperesthesia, lessened or increased secretion, congestion or anemia, hypertrophy or atrophy of the greater part of the lower limb. This nerve will be discussed more thoroughly in connection with the sacro-iliac joint; and suffice it to say in connection with the fifth lumbar that almost any disorder of the lower limb may result from a lesion of the fifth lumbar which affects the great sciatic nerve.

The **aortic plexus** possibly receives some impulses from the spinal cord over filaments that pass through the fifth lumbar foramen. This plexus supplies the blood-vessels in relation and the lower bowel, thus disorders of the lower bowel may complicate a lesion of the fifth lumbar. The iliac arteries are supplied by branches extending from the aortic plexus along these arteries, hence the amount of blood in the lower limbs is determined to some extent by the size of these arteries, that is, the condition of the nerves supplying them. From the iliac plexus is derived the femoral plexus and from this the popliteal; the impulses originally coming from the lumbar spinal cord.

The **hypogastric plexus** also receives impulses from the fifth lumbar segment by way of nerve filaments which pass out through the fifth

lumbar foramen. These filaments are more or less affected by a lesion of the fifth lumbar, hence the function of this plexus of nerves would be disturbed. This plexus supplies the internal generative organs and the lower bowel. From a clinical point of view, the parts most frequently affected are the rectum, vesicle seminales, uterus, prostate, bladder, ureter and urethra. The diseases associated with a lesion of the fifth lumbar and resulting from a disturbance of the hypogastric plexus by the lesion are (1) **rectal** disorders such as prolapsus, eversion, ulcers, tenesmus, hemorrhoids, pruritus ani or itching piles; (2) disorders of the **vesicle sesminales** and its adjacent structures, such as nocturnal emission, premature emission, imperfect emission, spermatorrhea; (3) **uterine disorders,** principally inflammatory conditions and relaxation, dysmenorrhea and reflex backache; (4) **prostatic enlargement** and weakness, such as prostatorrhea; (5) disorders of the **bladder,** such as frequent, painful and imperfect micturition, and cystitis with tenesmus and calculi; and (6) pain in **ureter** and urethra, or congestion and inflammation with change in size. Each of the above groups, receives its nerve impulses almost entirely from the hypogastric via the pelvic plexuses. The lesion of the fifth lumbar articulation affects the nerve filaments in relation which represent some of the nerves forming the above named plexuses. Even though these filaments be entirely destroyed, the other filaments helping to form these plexuses will, in part at least, take on the function of the disabled nerves but in most cases there is some effect on the structures supplied by these plexuses. The effects vary since the degree of disturbance, and the nerve filaments vary in cases in which the lesions are apparently the same.

The **recurrent meningeal** nerve and the twigs to the vertebra and ligaments are affected in a way similar to that from a lesion of the other vertebral articulations.

The fifth lumbar vertebra is a **weak point in the spinal column** and is the seat of reflex pains depending on disorders of the lower bowel and especially of the generative organs. In many cases the spinal column is turned or twisted on the pelvis or vice versa. In the first case there is no change in the relative position of the vertebra while in the second case, the other pelvic articulations are intact. The lesion is then entirely confined to the lumbo-sacral articulation. To differentiate between such conditions and a subluxation of the fifth lumbar vertebra, consider the articulations of the fourth and fifth lumbar vertebræ at

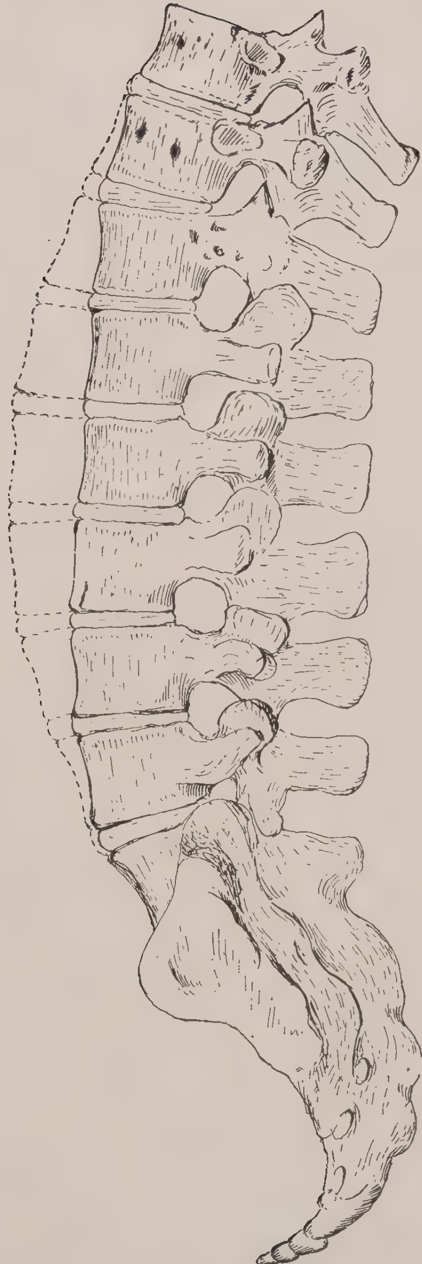

Fig. 73.—Showing effects from a straight lumbar region. The dotted line indicates position of bodies in extension. In such a position, the intervertebral foramina are lessened in size.

which joints there will be changes such as irregularity, thickening with congestion and tenderness if there is a lesion of the fifth.

Tenderness at the spine of the fifth lumbar vertebra, is not diagnostic of a lesion of its articulation. In many cases the tenderness is due to visceral disease that causes a reflex congestion of the posterfor division of the fifth lumbar nerve. It is not a true referred pain but one due to local changes in the circulation of the blood through the nerve affected. Pressure increases the amount of pain since it increases the blood-pressure in the nerve. The fifth lumbar vertebra is especially affected reflexly and on this account, pain on pressure over the spine of the fifth, is not diagnostic of a lesion of the articulation. Of course in many cases the pain on pressure is due directly to a lesion of the vertebral articulations in relation.

The **sacro-iliac** articulation is classed by some anatomists, as a practically immovable joint, that is as belonging to the amphiarthrodial joints, while it is described by others as having enough movement to be classed with the diarthrodial joints. This depends on the age of the patient as well as the condition of patient and joint. In a young person there is considerable movement at the articulation, while in the old there is very little, if any. In the cadaver, the articulation is practically immovable on account of the post mortem changes, on which account the various writers on the subject have determined that the joint is not subject to dislocation and that there was practically no movement in it. There is a great deal of difference in the degree of mobility in a cadaver and a living body, which difference can be demonstrated very readily. This applies especially to the vertebral and sacro-iliac articulations.

The **articular surfaces** forming the sacro-iliac articulation are auricular-shaped, rough, irregular and covered by a thin layer of hyaline articular cartilage. They are about one and three-quarter inches in length and about one inch in breadth at the widest or upper part. The articular surface of the sacrum is concave and faces upward and backward when the patient is in the erect posture. The writer has found that in young subjects the surfaces are smooth and glistening, indicating a synovial membrane and sac and mobility. In old subjects the surfaces are often adhered and as Cunningham states "the joint cavity, which is little more than a capillary interval, may be crossed by fibrous bands."

The joint is supported and strengthened on all sides by **ligaments** which have been arbitrarily divided into the anterior and posterior,

superior and inferior sacro-iliac, and the interosseus. The **anterior** and **superior** are short and comparatively thin; the **posterior** are larger and stronger. The fibers are almost transverse and arranged in ridges between which are foramina, for the transmission of the posterior sacral nerves. The **interosseus** is the strongest of all these ligaments. The fibers are of unequal length and pass in different directions, thus pro-

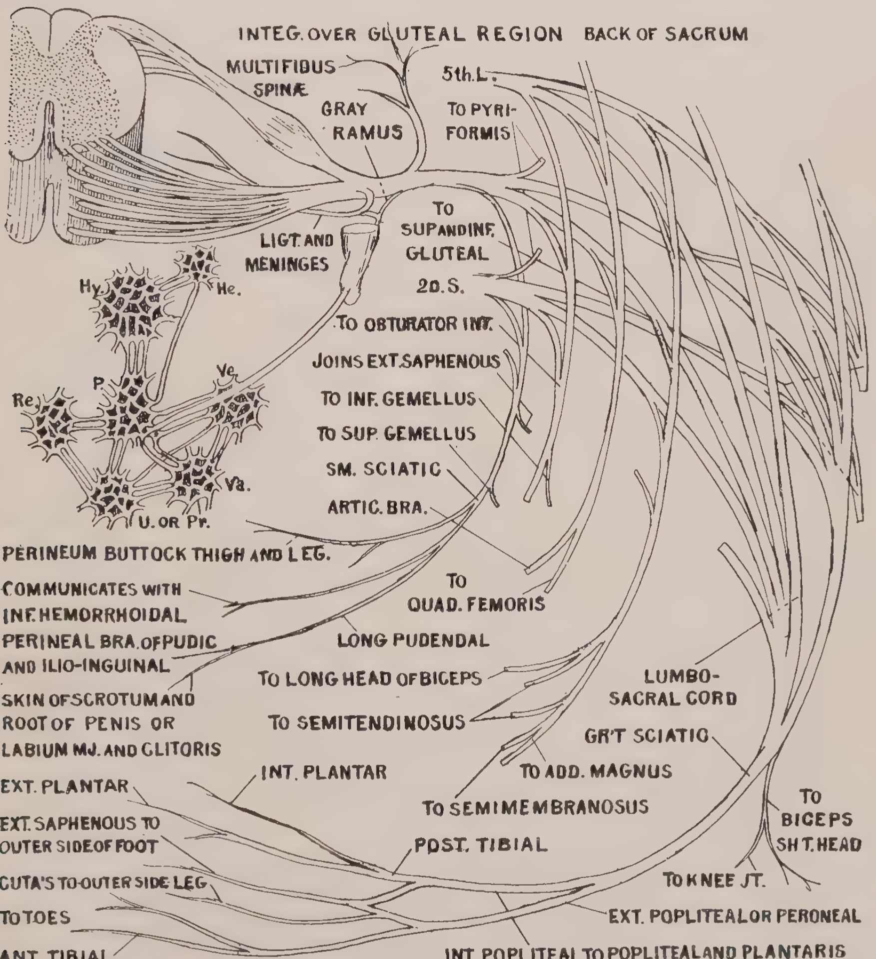

FIG. 74.—The first sacral segment of the spinal cord, with its nerves and their distribution.

ducing a crossing or interlacement which strengthens the joint. The lumbo-sacral and ilio-lumbar, indirectly support and strengthen this joint since they help to support and steady the sacrum.

The great **sacro-sciatic** ligament extends from the posterior crest of the ilium and posterior iliac spines downward and backward to the sacrum (the lower three segments) and upper part of the coccyx, while a part of the fibers reach the ischium. The sacrum is, to a great extent, supported by these ligaments. The sacrum is not the keystone of the pelvic arch but is shaped in just the opposite way, that is the widest part is anterior and inferior. The sacro-sciatic ligaments counteract the downward tendency of the upper part of the sacrum from the superimposed weight of the body. They are important in determining the character of the innominate lesion. A great many of the lower fibers pass on into the tendon of the biceps muscle "so that traction on this muscle braces up the whole ligament, and the coccyx is thus made to move on the sacrum." (Morris).

The **movement** at this articulation is slight. In the young it is quite well marked, also during pregnancy, but in the old, it is slight and quite commonly, is entirely lost. From clinical indications in cases treated by the writer, from examination of pregnant cases and from dissections made there remains no doubt in my mind but that the sacro-iliac joint is a diarthrodial articulation.

*"The large amount of clinical and anatomical study, which has been carried on in connection with this subject during the past two years makes it quite plain that the pelvic articulations, especially the sacro-iliac synchondroses, are by no means as stable as has been supposed, and that in man and woman under normal conditions, definite motion exists. It is also shown that the articulations are true joints having all of the common joint structures, and that this being the case, they are naturally subject to the same diseases and injuries as the other joints. When this is once appreciated the character of the articulations is considered, and especially when it is remembered that the exact apposition of these bones is maintained almost entirely by the ligaments, the surprising thing is, not that abnormal mobility, and disease of the joints ever do occur, but that they do not occur more frequently." Its nerve supply is derived from the sacral plexus, first and second sacral nerves, posterior divisions, and the superior gluteal nerve.

*Goldthwait, Boston Med. and Surg. Journal, Vol. CLII, No. 21, p. 594.

The **structures** in relation with this articulation and which would be affected by a subluxation of it are (1) ligaments uniting the two bones, sacrum and ilium; (2) nerves, the branches going from the **sacral plexus** and the **anterior sacral nerves;** (3) and some blood-vessels, mostly branches of the **ilio-lumbar** vessels. The periosteum will be affected by a lesion at this joint, also what connective tissue there may be in

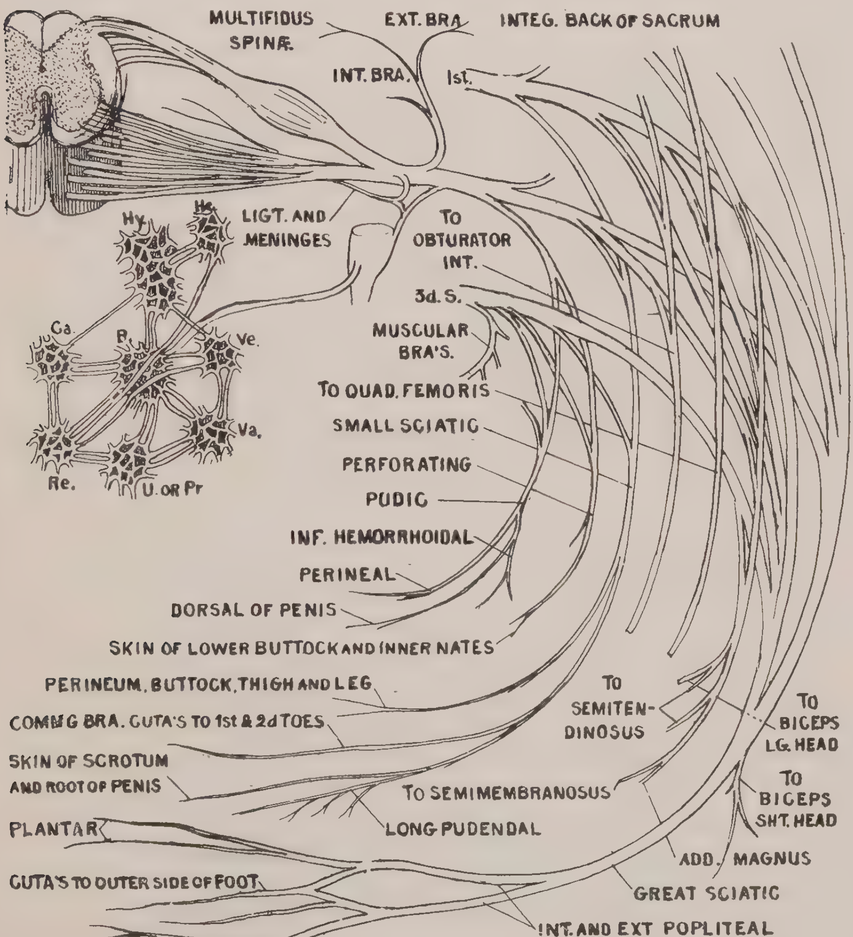

Fig. 75.—The second sacral segment of the spinal cord, with its nerves and their distribution.

relation, which binds the roots of the sacral nerves quite firmly to the articulation and adjacent bones.

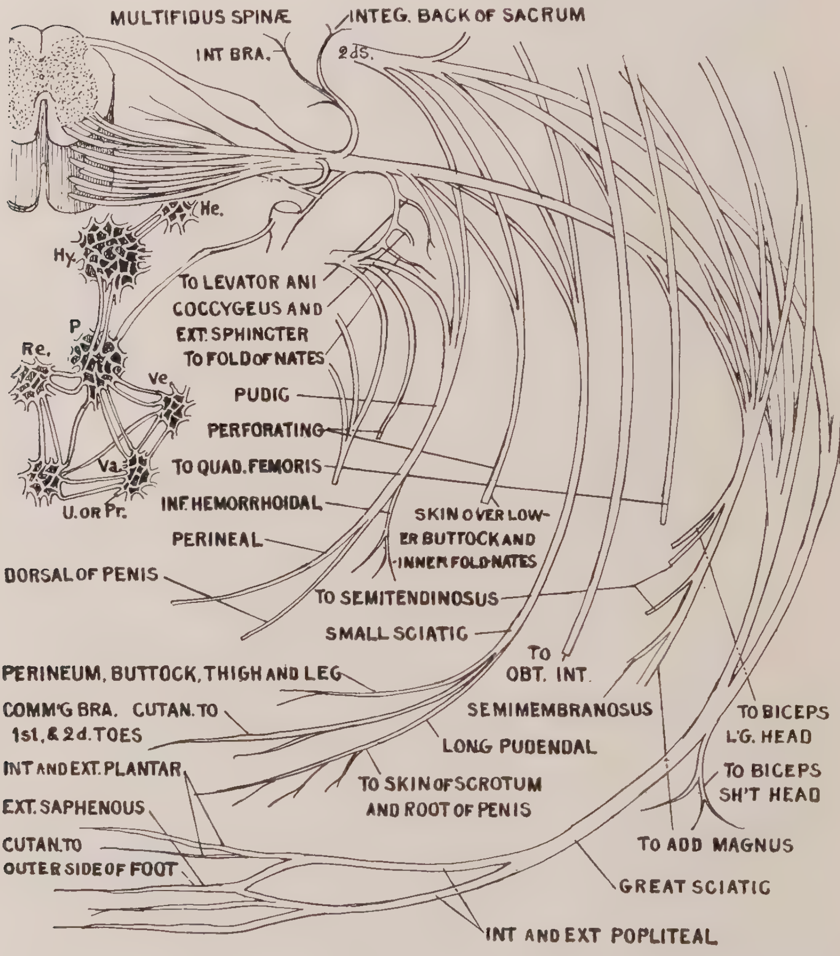

FIG. 76.—The third sacral segment of the spinal cord, with its nerves and their distribution.

THE INNOMINATE.

The **innominate,** the bone which, according to the ancients, bore no resemblance to any known thing, is irregularly shaped and with its fellow of the opposite side, forms the lateral walls of the pelvis. In early life, it is composed of three parts, the ilium, pubis and ischium, which unite to form one solid bone.

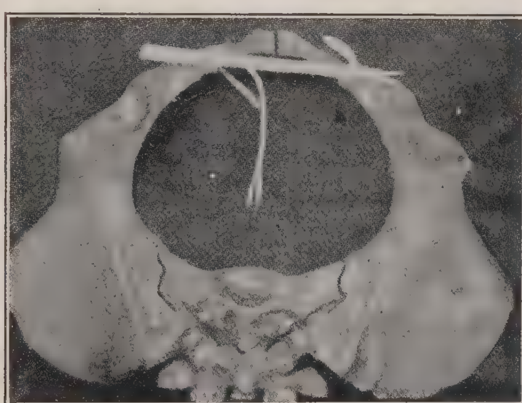

Fig. 77.—The sacro-iliac articulation, with bones in place. (Goldthwait).

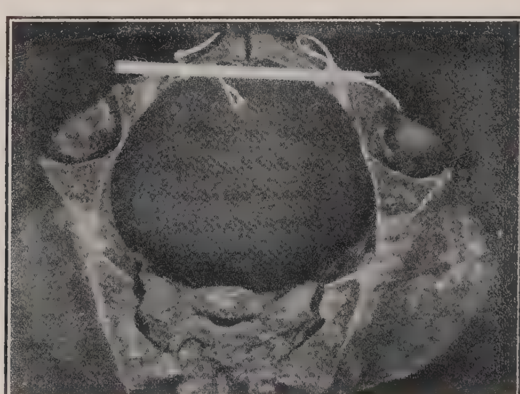

Fig. 78.—Sacro-iliac articulations with the sacrum slightly tilted showing the separation of the iliac at the pubis as well as at the back. (Goldthwait).

The **ilium** is the upper part which helps to form the false pelvic cavity. It flares considerably, the degree of which determines the size of this cavity. It has anterior and posterior spines, which points are regarded as landmarks for the location of viscera and for the diagnosis of changes in the position of the trochanter, sacrum, spinal column and the relation of one innominate to the other. It has a crest, along which

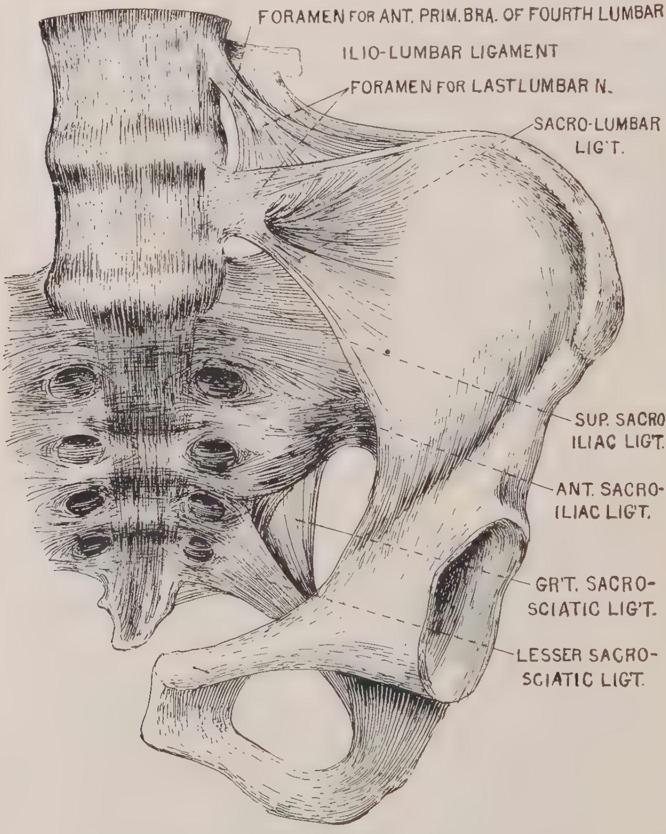

FIG. 79.—Anterior view of the posterior wall of the pelvis showing the ligaments connecting the sacrum, innominate and lumbar vertebræ.

pain is often complained of in pelvic disease. The direction of the crest is changed in subluxations of the bone and it should be examined in all suspected cases.

The **ilium** gives attachment to many muscles which, on account of the peculiar shape and size of the bone, are widely and firmly attached. In all pelvic examinations, the two ilia should be compared as to height, direction, degree of flare, spines, tenderness and condition of muscles attached.

The **ischium** is of importance in that in subluxations of the innominate its position, is altered and the structures attached to it usually tightened. Falls on the tuberosities of the ischia often produce a subluxation at the sacro-iliac articulation. The tuberosities are made the fixed point in the reduction of many subluxations of the innominate, which is accomplished by firmly holding them against an unyielding surface while the body is bent in various ways. The ischia often retard the progress of the fetal head in parturition and in elderly primiparæ, labor is often delayed on account of it. The **landmarks** of the ischium are the tuberosity, spine and ramus. The tuberosity is that part which supports the body while in the sitting posture. It gives attachment to the hamstring muscles, adductor magnus, gemellus inferior and quadratus femoris. The spine gives origin to the levator ani, gemellus superior and coccygeus. The pudic vessels and nerve are in relation with this spine and are often affected by falls or by faulty posin sitting. The ischium helps to form the acetabulum.

The **pubes** consist of a body and rami. They are of importance in that they form the anterior boundary of the pelvis, give origin to important structures, are subject to slight separation during parturition, and their articulation, the symphysis pubis, is always affected in subluxations of the innominate. In rachitis, the pubic arch is generally flattened or distinctly angular. The principal landmarks are the rami and ilio-pectineal eminence.

The innominate articulates with its fellow, the hip and the sacrum, and in all subluxations of it, all these articulations are more or less affected.

The **sacrum** is a composite bone formed by the union of the five sacral vertebræ. It is a large, curved, triangular or wedge-shaped bone forming the posterior boundary of the true pelvic cavity. When the patient is in the erect posture, it is at quite an angle, the upper part receiving the weight of the body which is then passed through the long axis of the sacrum but at an angle with the body. On this account in cases of rachitis, the bone is likely to bend under the superimposed weight of the body and a deformity occurs. In other cases, the bone may turn

instead of bend, and a lesion at the sacro-iliac articulation is the result. It articulates above with the fifth lumbar, on both sides with the innominata, and below with the coccyx. The superior articular facets are similar to those of the lumbar vertebræ except that they are larger, more concave and considerably wider apart. This articulation has been considered in the discussion of the fifth lumbar vertebra.

FIG. 80.—Showing the right side of the sacrum. Note the articular surfaces.

The **sacro-coccygeal** articulation will be treated of under consideration of the coccyx.

The **posterior surface** of the sacrum is convex, and quite rough on account of the spines of the coalesced sacral vertebræ and the ridges, the remains of the laminæ. The posterior divisions of the sacral nerves emerge through foramina on this surface. On this account, these nerves

can be reached quite directly and advantage is taken of this in cases in which a quick result is wanted; that is, palliative effects can be obtained by stimulation or inhibition of these nerves. As a rule irritation of the anterior divisions of these nerves, will produce some effect on the posterior divisions, that is metritis is characterized by tenderness over the posterior surface of the sacrum, especially at the sacral foramina. The **degree of convexity** of this surface varies in different subjects. It is usually lessened in posterior conditions of the lumbar region and increased in anterior conditions. **If the fifth lumbar vertebra becomes anterior it,** in the average case, **carries with it the upper part of the sacrum.** If the upper part of the sacrum is anterior, a "hump" will be formed at the sacro-coccygeal articulation; in other words, the angle formed by the two bones becomes more acute. This surface gives origin to the multifidus and erector spinæ muscles, and the gluteus maximus.

The **anterior surface** is smooth and markedly concave. It is pierced by the sacral foramina for the transmission of the anterior sacral nerves which, after emerging, pass almost directly outward in grooves. There are indistinct ridges resulting from the union of the bodies of the vertebræ. This surface gives origin to the pyriformis and a part of the coccygeus muscles. In tumors or other enlargements of the pelvic viscera, these sacral nerves are subject to pressure which, in the average case. becomes quite painful. The degree of concavity differs in the male from that in the female and at different ages in the same subject. In the male, the sacrum is narrow, considerably more curved and not directed so obliquely backward as in the female.

The **lesions of the sacro-iliac articulation** will be considered from two points of view: (1) those resulting from subluxations of the innominate bone; and (2) those from subluxations of the sacrum.

The innominata are subject to partial displacements, in fact an innominate lesion is one of the most common of all bony lesions. The reason for it is (1), the large size of the bone and the small size of the articulation, which increase the lever power; (2), the many and powerful muscles attached to it, which when brought into use, increase the lever power mentioned above; (3), the exposed position of the bone, it bearing the brunt of lifting and other muscular exertions and (4) transmitting at an angle the pressure exerted from below, as in jumping, or that from above, as in the carrying of a weight.

The bone is most commonly rotated backward and upward on ac-

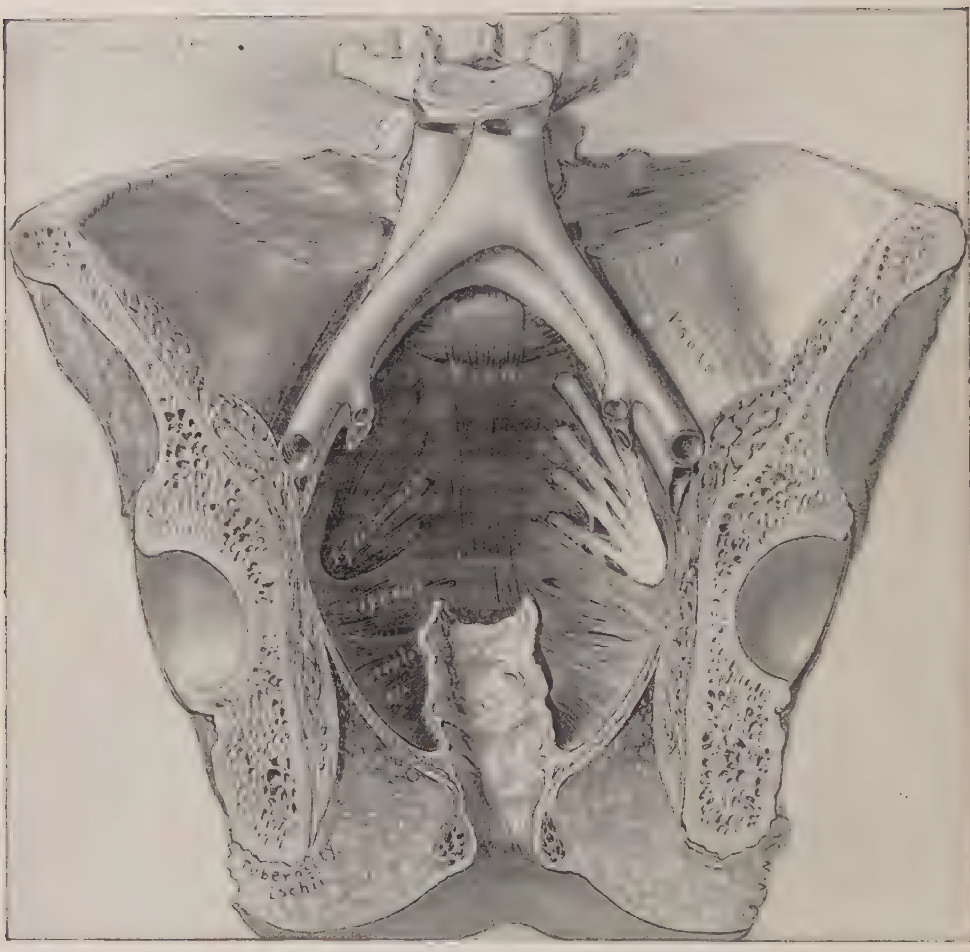

Fig. 81.—A coronal section of the pelvis through the iliac crests, the acetabula, and the tuberosities of the ischium, showing the posterior part of the pelvis and the levator ani muscles and rectum in vertical section. (Kelly).

count of the shape of the sacro-iliac articulation and since the force is directed most frequently and with greatest intensity, from below upward at a point anterior to the sacro-iliac synchondrosis, i. e., the acetabulum. The bone may be dislocated directly up, down or any other way; there may be a separation, but usually there is a combination of two or more, in the average case; that is, instead of being displaced directly upward it is at the same time rotated backward, or there is some other combination. Many subluxations of this bone come from falls, muscular exertion or other conditions that exert a marked strain on the articulation. Parturition is an important cause. Straining while in a stooping posture is another important one.

The **diagnosis** is based on irregularity at the articulation, tenderness and disturbance of function of the structures attached to and in relation with it. For example, if one of the posterior spines is more or less prominent than its fellow, or if there is a tenderness at the joint often accompanied by small tumefactions, or if there are pressure symptoms in some of the nerves in relation, such as the roots of the sciatic nerve, the chances are that the bone is subluxated. If there is a combination of two or more of these indications, the diagnosis need not be doubtful. As to the particular form of subluxation the height of the crest, spines and other landmarks must be compared with the sound side, as also must the prominence or other changes be compared. The length of the limb is indicative but not diagnostic; for example, if the limb is slightly shorter on the affected than on the sound side, it indicates an upward and forward displacement but is not diagnostic of it. In making the differential diagnosis, rely on palpation and inspection rather than on symptoms, noting prominences, depressions, or in short the many slight changes in contour.

In order that this be done to the best advantage, the examination should be made in several different postures, i. e., the erect, sitting and dorsal and ventral. By so doing it will be easier to differentiate between the changes produced by a slight shortening of one limb, a slight lateral curvature, a torsion of the spinal column on the pelvis and subluxations of the innominate. Of all these postures, the ventral is the best, since in this the relation between the spine and the pelvis can the better be ascertained.

The **effects** of a lesion of the innominate are many and varied. Considerable force is usually exerted in the production of all lesions of

this joint. This is because of the shape, size and character of the articulation. The joint itself is injured to a greater extent than the joints in vertebral lesions. The articular cartilage is often torn and sometimes the synovial sac is broken, or at least impaired, as is indicated by the swelling and formation of lumps over the articulation. The **sacro-iliac** ligaments are stretched, or even partly torn in most instances, the effect is that of any sprain on the ligaments in relation. They become tender and thickened and their function is often considerably perverted. In chronic cases, the ligaments become shortened, and approximation with lessened mobility, as in the vertebral articulation, is the result.

The **blood-vessels** in relation with this articulation are the ilio-lumbar, lateral sacral and gluteal. The **ilio-lumbar** is nutrient to the ilium and furnishes a spinal branch, which passes upward into the spinal canal carrying nutrition to the lowest part of the spinal cord or cauda equina. The **lateral sacral** has to do with supplying the spinal membranes. The **gluteal,** supplies the muscles in the pelvic cavity also the pelvic bones, the gluteus maximus, the hip-joint, and the muscles contiguous to the hip-joint. These vessels are more or less affected because they send branches to the articulation and are, in a part of their course, in relation with this joint. The effects of a disturbance of them can be determined by referring to their functions outlined above, the principal effect being that on the hip-joint and pelvic bones. Malnutrition of these parts may follow the lesion. This condition leads to hip-joint disease, dislocation of the hip and imperfect development of parts if the lesion occurs before the parts are completely developed.

The **veins** correspond to the arteries and would be affected by the lesion in a way similar to the arteries. The effects would be manifest in the muscles around the hip-joint, those inside the pelvis, and the hip-joint and pelvic bones.

The **nerves** more or less affected by a lesion of this joint because of their relation and juxtaposition, are the **pudic, small sciatic, muscular, visceral** or nervi erigentes, and the **great sciatic.** The nerve impulses passing over the above named nerves come from the spinal cord, sacral segments, by way of the anterior nerve roots. Each of the above mentioned nerves with its branches, is represented in these nerve roots by filaments. These nerve roots, especially the lumbo-sacral cord, the first, second and third sacral, pass across and are quite firmly bound down to the anterior surface of the sacro-iliac articulation, and thus would

be affected by the slightest deviation of either of the bones forming this joint. On account of the great number of nerve filaments and the variations in degree of the lesion, the effects are not the same for lesions that appear to be identical in different subjects. In one case there may be pressure on, or irritation of, the filaments which carry impulses to the uterus, while in another case apparently identical in character, the pres-

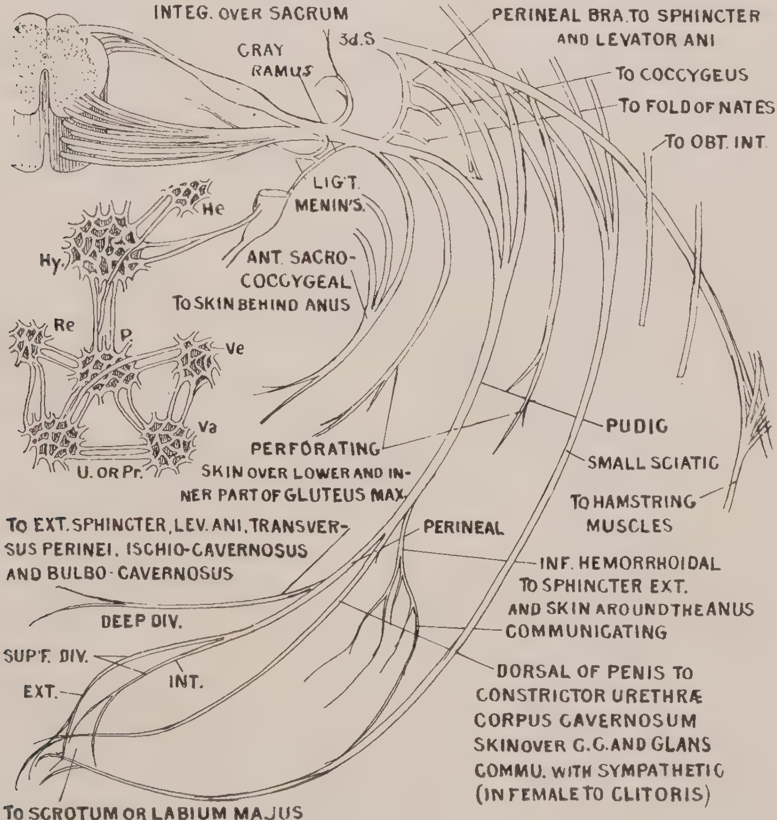

FIG. 82.—The fourth sacral segment of the spinal cord, with its nerves and their distribution.

sure or irritation caused by the subluxation may affect the nerve filaments controlling the second phalanx of the foot.

The thickening of the ligaments in relation with the articulation

in consequence of the arthritis that often follows the injury to the joint, is responsible for many of the effects on the adjacent structures. Unless the subluxation is the result of a relaxation, this thickening will be present in practically all cases. In the worst cases an osteitis develops and this like the arthritis, leads to disturbances of the tissues in relation. Goldthwait points out that in some forms of arthritis the inflammation may extend to the neighboring parts. "It is in this hypertrophic form that the joints at times become entirely fused and that the persistent sciatica or leg pains are so commonly seen. These referred pains are

Fig. 83.—The bony pelvis with its ligaments attached. Drawn from a dissection.

undoubtedly due to the pressure of the hypertrophic tissue upon the lumbo-sacral cord as it passes over the articulation."

These nerve roots also carry impulses for the innervation of the sacro-iliac articulation, thus furnishing an additional reason for the assertion that a lesion of the innominate will affect the sacral plexus.

The **pudic nerve** is often affected by a lesion of the innominate because the roots forming it are in relation with this articulation. This nerve is motor and sensory to the perineum and the external genitalia, and is the nerve of voluptuous sensation. It divides into the inferior hemorrhoidal and perineal branches and terminates in the dorsal nerve

of the penis. The **inferior hemorrhoidal** is **motor** to the external sphincter muscle and sensory to the integument around the anus. The sphincter ani externus, is a voluntary muscle surrounding the anus and attached to the tendinous center of the perineum and the tip of the coccyx. Its function is to maintain closure of the anus and to retain the contents of the lower bowel, especially in muscular efforts in which the intra-abdominal pressure is markedly increased. In vomiting, coughing and difficult micturition, or any muscular exertion, the intra-abdominal and intra-pelvic pressure is increased to a great extent and the tendency is, to cause expulsion of the contents of the bowel. Exercise is almost absolutely necessary for the normal activity of the bowels since the contents are forced lower by it. Lack of exercise is a prolific cause of constipation. The lesion may stimulate the nerve to the external sphincter muscle, hence the resistance offered to the expulsion of the feces would be increased in proportion to the degree of contraction. Constipation from obstruction is the result. In such cases the fecal contents are normal as to shape and consistency, but the stool is small and is expelled only after great straining. To cure such cases, correct the lesion, that is, remove the irritation. The muscular condition is the effect. To relieve, dilate the rectum thus overcoming or removing temporarily, the resistance offered by it. If the lesion inhibits this nerve, the sphincter muscle relaxes and its function is impaired, it failing to firmly close the anus. This muscle being voluntary, certain psychic effects may be obtained by an effort on the part of the patient.

The **inferior hemorrhoidal** nerve is also **sensory** to the integument around the anus. The most common effect of the lesion on this nerve, is pruritus ani or itching piles. The disturbance is along the nerve trunk, the effect at the periphery. There may be anesthesia, numbness or distinct pain in this area; it depending on the condition of the nerve and the kind of lesion.

The **perineal** branch of the pudic is sensory to the integument of the perineum and a part of the external genitalia, and motor to the muscles of the pelvic floor. If the lesion is irritative there will be pain referred to the perineal body, the integument of the scrotum, or the labium majus in the female; if paralytic, numbness or complete loss of sensation in these parts will follow. The perineal branch of the pudic supplies the levator ani muscle. The function of this muscle in conjunction with its fellow of the opposite side,is to close a greater part of the outlet

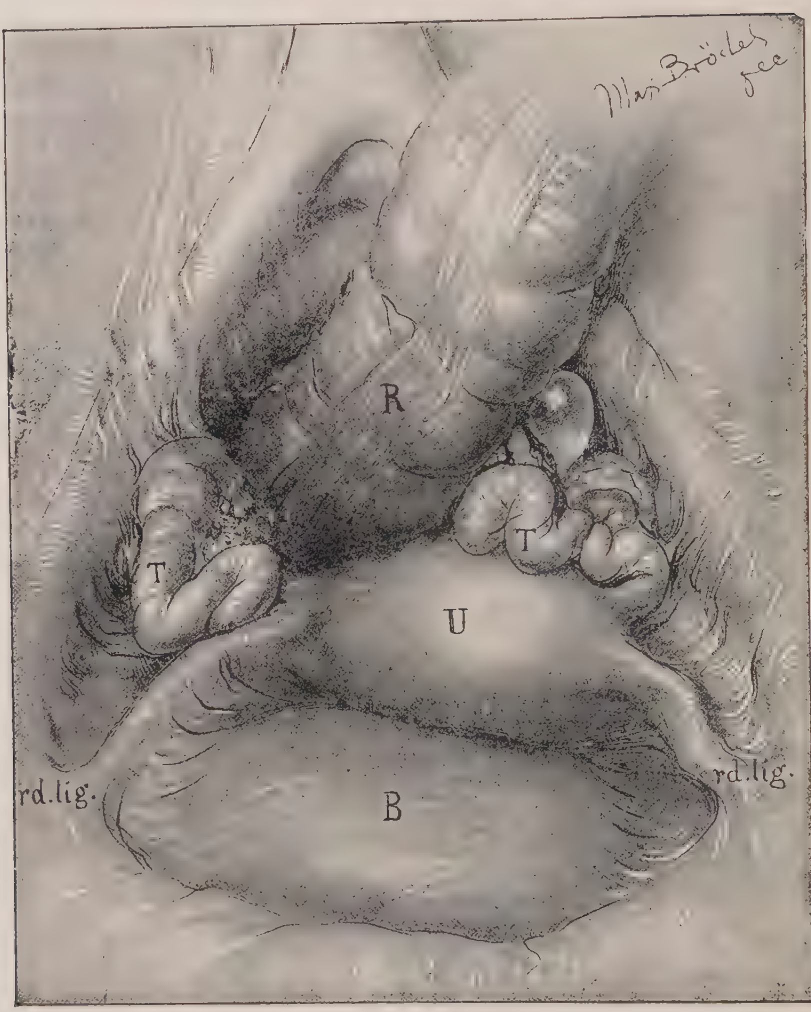

FIG. 84.—Showing the mutual relations of the pelvic viscera as seen upon opening the abdomen through the superior strait. (Kelly).

of the pelvic cavity, support the pelvic contents and, by its contracture, quite securely close the openings in the pelvic floor. By its contraction, the perineal body is drawn upward and forward, and in the female, the posterior vaginal wall is drawn against the anterior, thus lessening the size of the vaginal canal. Morris says: "It is possible that it exercises some influence upon the circulation in the prostatic plexus and in the large pelvic veins which occupy the recess between the muscle and the viscera, and may also assist in the expulsion of the prostatic secretion by direct lateral compression of the organ." If the lesion inhibits this nerve, the muscle relaxes; the above named function would be partly or completely suspended; the openings in the pelvic floor become patulous and the floor sinks and remains in a position of descent, every pelvic structure resting on it sinks to a lower level, hence cystocele, rectocele and prolapsus uteri are the results; the veins dilate, resulting in malnutrition and varicosities. An innominate lesion produces such effects by breaking or otherwise interfering with the nerve connection existing between this muscle and the spinal cord. If the lesion irritates the nerve, the muscle will be in a state of constant contraction, and constipation and vaginismus are the most common results.

The lesion may inhibit the nerves supplying the other perineal muscles, the compressor urethra and erector penis, causing imperfect erection. If the lesion is irritative, priapism and satyriasis may develop, but ordinarily these diseases come from spinal cord affections. The perineal branch of the pudic also supplies a part of the urethra, the bulbous portion.

The **dorsal nerve** of the penis, the terminal branch, supplies the corpus cavernosum, the skin of the dorsum of the penis, the prepuce and the glans. The dorsal nerve of the clitoris of the female is distributed in a similar way. This nerve is principally sensory and perhaps has a peculiar and distinct function. It supplies one muscle, the constrictor urinæ. If the lesion affecting this part of the pudic nerve is paralytic in its action, there would follow lack of orgasm, numbness or anesthesia of the parts innervated and relaxation of the muscle supplied. Lack of orgasm in both male and female is not an uncommon condition and is due to disturbance of function, that is suspension of function of this nerve. Loss of sexual desire is another sequel of such a lesion. Impotency is also common. If the lesion is irritative, the opposite effects would result, viz., priapism, premature ejaculation and orgasm, excessive or

unnatural sexual desires, or painful conditions of the glans penis and prepuce. Other disorders of the glans and prepuce may complicate the innominate lesion. A case of paraphimosis in a baby was reported to me as cured by correcting a slight subluxation of one innominate. The pudic nerve was undoubtedly affected by the lesion with the rather unusual effect, paraphimosis. The pudic nerve may be affected by other lesions or disturbed by pressure from **faulty posture in sitting,** being compressed between the tissues and the spine of the ischium around which it turns. This nerve has to do mostly with the sexual function but also supplies the muscles of the pelvic floor. If it is stimulated by a le-

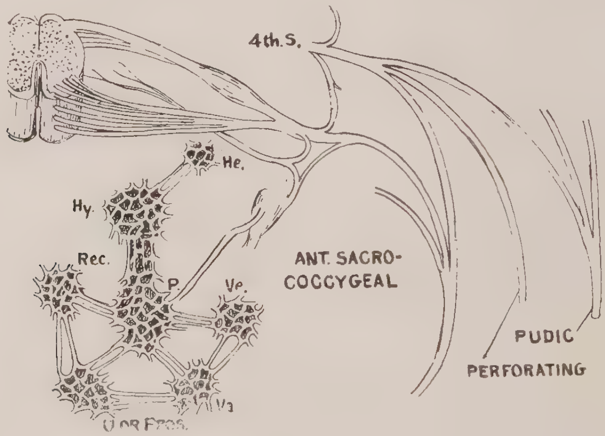

FIG. 85.—The fifth sacral segment of the spinal cord, with its nerves and their distribution.

sion or otherwise, the muscles contract and the activity of the sexual apparatus is increased. This is well illustrated in cases of masturbation in the early stages. If the nerve is inhibited, whether from a lesion or by abuse, the muscles of the floor relax and the sexual sense is dulled or entirely lost. The condition of the pelvic floor is a pretty sure indication of the condition of the sexual organs. This can be better demonstrated in the female than in the male. A relaxed and patulous vagina is almost diagnostic of loss, partial or complete, of the sexual function, that is orgasm is partly or completely gone. The opposite condition is almost diagnostic of a normal functioning of the part.

The **small sciatic** nerve is almost if not entirely sensory in function.

It arises from the first, second and third sacral segments, passes out in relation with the lower border of the pyriformis muscle and descends in relation with the great sciatic nerve and the gluteus maximus. It gives rise to three principal branches, the gluteal cutaneous, femoral cutaneous and the long pudendal. If the lesion affecting the filaments of the gluteal branch is irritative, there will be superficial pain over the lower and outer part of the gluteal region; if inhibitive, there will be numbness or perverted sensation in this area.

The **femoral cutaneous** filaments supply the integument over the back and inner side of the thigh. The **inferior pudendal** is distributed "to the skin of the upper and inner part of the thigh, and is continued forward to the outer part of the scrotum (or external labium pudendi), where its terminal filaments are distributed, after forming communciations with the external superficial perineal branch of the pudic nerve." (Quain). An irritative lesion of the innominate will cause pain or perverted sensation in the above named parts. Pruritus vulvæ is an example. Nymphomania and masturbation or excessive venery, often result from such a lesion on account of the effect on the labia. Lack of sensation would follow a paralytic lesion.

The **small sciatic,** extends down the limb and becomes subcutaneous a little below the knee. It supplies the integument over the calf of the leg. On account of its origin, the sacral segments, its communications with the pudic nerve and its branch, the long pudendal, diseases of the genitalia often produce cramping or pain in the calf of the leg. This may be due to a disturbance of the great, as well as the small sciatic nerve. On account of its cutaneous distribution over the gluteal and femoral regions and its connection with the pudic, and the fact that it also supplies the pudendum, stimulation of the gluteal region excites the sexual passion. In sexual perverts, this sort of stimulation is resorted to in order to arouse the sexual passion. Some writers have pointed out that the frequent spanking of a child often leads to sexual irritation or disorder. Perhaps this is true in exceptional cases since it is anatomically possible, on account of the distribution of the small sciatic and and pudic nerves.

There is a perforating cutaneous nerve, which receives its name from the fact that it penetrates the great sacro-sciatic ligament, and becoming cutaneous, supplies a part of the integument over the gluteus maximus muscle..

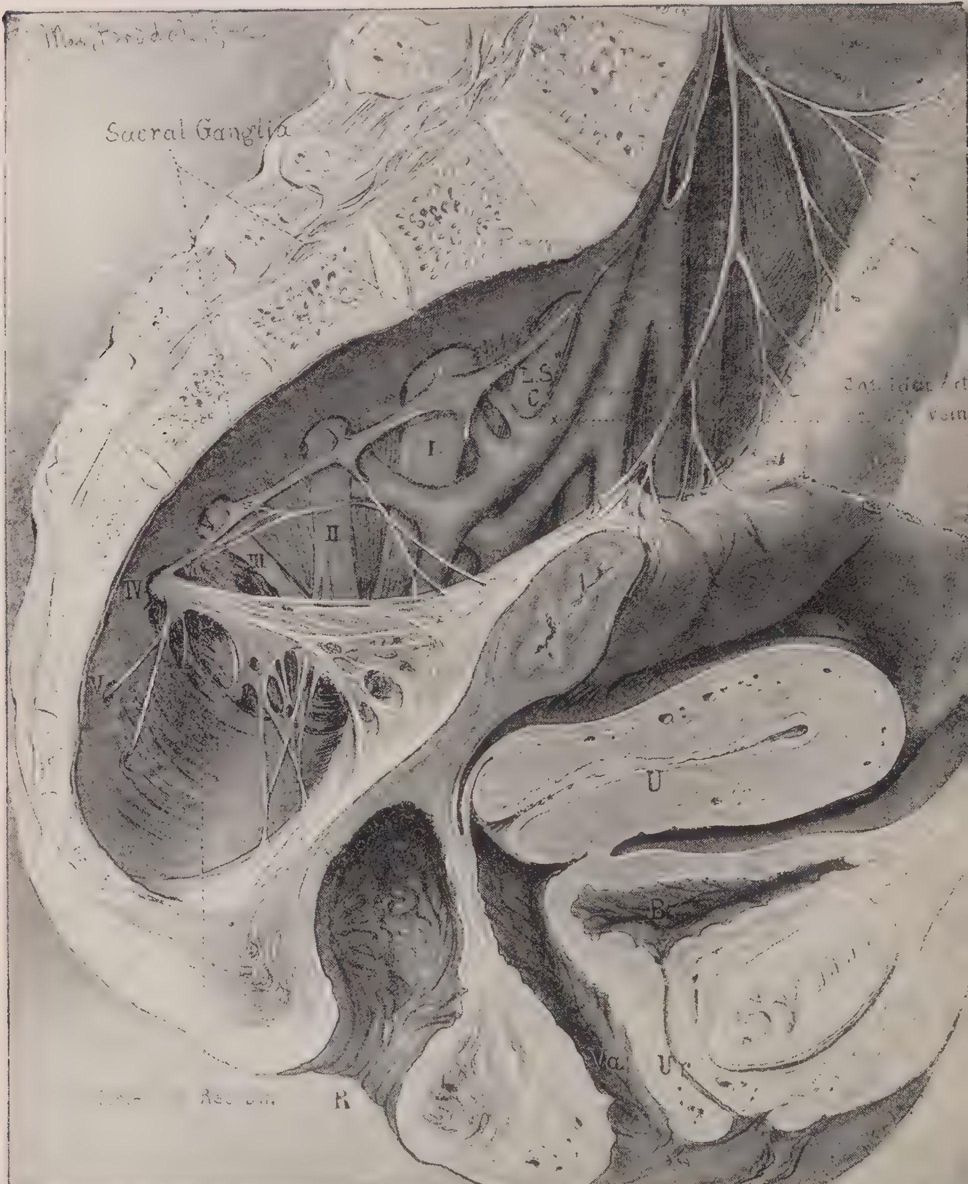

FIG. 86.—A sagittal section of the pelvis, showing the rectum drawn away from the sacrum in order to demonstrate the arteries, veins, and nerves of the sacral and lateral pelvic regions. (Kelly).

The **nerve to the quadratus femoris muscle,** is represented by filaments in the anterior roots of the sacral nerves, and would be more or less disturbed by a lesion of the innominate. The function of this muscle is to externally rotate the femur. If the nerve were stimulated, the muscle would contract and external rotation would result so long as internal rotation of the femur would be difficult.

The nerve to the obturator internus would also be affected by this lesion, the effect being very similar to that on the quadratus femoris.

The superior and inferior gluteal nerves have been considered. The effect of an innominate lesion on them would be similar to that of a lesion of the fifth lumbar.

Cunningham speaks of the visceral branches of the anterior sacral nerve roots as white rami communicantes. Another writer has spoken of them as the pelvic splanchnics of Gaskell. At any rate, branches are given off from the **second, third and fourth sacral roots** that pass into the inferior hypogastric or pelvic plexuses and eventually reach the pelvic organs. The function of these visceral branches is principally motor, but possibly in addition, vaso-motor, trophic, secretory and sensory impulses are transmitted by them unless they are very different in character from the average white rami. Some of these branches, called the middle hemorrhoidal, supply the rectum. If the lesion stimulates this nerve, the longitudinal fibers of the rectum contract, the lumen of the bowel is lessened and constipation from obstruction is the result. Quain, in speaking of the nerve supply of the rectum, says: "Experiments upon animals have shown that the longitudinal muscular fibers of the rectum are supplied with motor fibers from the anterior roots of certain of the sacral nerves (second, third and in part, the first in the dog) which nerves also supply inhibitory fibers to the circular coat, whereas the fibers of the hypogastric plexus which supply the circular muscular tissue with motor fibers, are derived from white rami communicantes of the anterior roots of certain of the lumbar nerves, which join the sympathetic chain and lose their medullary sheath before passing to their distribution in the muscular coat." Thus the effects of a lesion disturbing these nerves can be the better understood when their function is known.

The second, third and fourth send fine medullated branches directly to the pelvic plexus and indirectly (possibly directly) through the plexus to the bladder. Quain says that they are the chief motor nerves to the bladder and are probably distributed to the longitudinal muscle fibers.

An innominate lesion may thus affect the bladder from injury to these nerves. Any sort of motor disorder of the bladder may be the result. If the lesion is irritative, there will be frequent micturition and tenesmus; if the lesion inhibits the passing of the motor impulses designed for the bladder, there will be difficult and imperfect micturition or motor paralysis of the bladder with dribbling of urine.

The **nervi erigentes** comprise the principal visceral branches of the sacral nerves. These are named the **pelvic nerve** by Langley and Anderson. The origin of the pelvic nerve varies in different animals but ordinarily it is formed by the visceral branches of the second, third and fourth with the first usually contributing a few fibers. *"Stimulation of the pelvic nerve causes strong contraction of the bladder, but has no certain effect on the blood-vessels of the organ; it causes contraction varying in strength, of both coats of the descending colon and rectum, the effect being much more constant, and generally greater, in the rabbit than in the cat and dog; strong contraction of the recto-coccygeal muscle and of the other special muscles of the rectum; dilatation of the vessels of the mucous membrane of the end of the rectum, and of the external generative organs; inhibition of the proper unstriated muscle of the external generative organs, notably the retractor of the penis; inhibition in the rabbit of the internal anal sphincter, and of some unstriated muscle in the skin of the ano-genital region."

The distribution and function of this nerve in the human, is probably very similar to that in the above named animals and consequently, the effects obtained from stimulation of the one, will in a measure apply to the other. These nerves that go to form the pelvic nerve, are in relation with a part of the sacro-iliac synchondrosis and will be more or less affected by a lesion at this articulation. The lesion will either stimulate or inhibit the passing of impulses over this nerve as a result of which there may be two effects from the lesion, that of lessened activity and that of increased activity. The function of this nerve, its relation to the synchondrosis and the effect of the lesion on it, explain many of the cases of disorders in which the bladder, bowel and genitalia are involved.

Some of these visceral branches go across to the vagina, supplying it with motor impulses. The size of the vagina, unless its muscle fibers have been torn, is determined by the condition of the nerves supplying its muscle fibers, hence these branches help to control the lumen of the

*Schæfer's Phys. Vol. II, p. 667.

vagina. An irritative lesion will, if the irritation is marked, produce vaginismus, a sort of spasmodic contraction of the vaginal walls. Inhibition over the sacrum will often temporarily relieve this condition. The explanation is that the anterior branches corresponding numerically to the ones inhibited by the treatment, supply the vaginal walls and through the effect on the posterior division and effect on the corresponding segment, the irritation is overcome, or the transmission of the motor impulses is suspended or checked. The better explanation of the effect of the sacral treatment is that the lesion is corrected and thus is removed the cause of the irritation to the vaginal nerves. The opposite condition exists if the lesion inhibits, instead of stimulates these visceral branches.

The **motor filaments** to the circular muscle fibers of the uterus come almost entirely from the visceral branches of the sacral nerves. The function of these circular fibers of the uterus is to oppose the contraction or rhythm of the longitudinal fibers and to regulate the size of the outlet or os uteri. In normal cases, the longitudinal and circular fibers work together; that is, when the longitudinal fibers contract, the circular fibers relax, as in menstruation and parturition. At other times the circular resist the action of the longitudinal. The condition of the circular fibers is governed by the number and character of the motor nerve impulses reaching them. If they are stimulated, the size of the os is lessened and vice versa. **In innominate lesions,** these visceral **branches supplying the uterus are more frequently affected in the female than any** other of the visceral nerves. If the lesion stimulates the nerve, contraction of the cervix follows, producing **dysmenorrhea** and **dystocia.** If the lesion inhibits the nerves, the cervix and a great part of the body relax, the os uteri becomes patulous, the blood-vessels are engorged, the weight of the uterus increases, and its secretions are increased and perverted. The **size of the uterine blood-vessels** is determined to a great extent **by the degree of contraction of the uterine muscle fibers. Menorrhagia** sometimes results from a subluxated innominate because of effect on the muscle fibers of the uterus which relax, the blood-vessels becoming larger, hence congested. Any motor disturbance of the uterus may follow an innominate lesion on account of its effect on the uterine muscle fibers. It has not been definitely determined as to whether or not these visceral uterine branches carry other than motor impulses, but I surmise that they, like the splanchnic nerves, do.

The various uterine disorders resulting from innominate lesions could

the more easily be explained if this assumption were definitely proven.

Some of these nerve fibers supply the **posterior uterine ligaments,** especially the sacro-uterine, the function of which ligament is to support, to a great extent, the uterus. The attachment of these ligaments furnishes a pivot around which the uterine movements take place. If this nerve is stimulated, the uterus will be drawn upward in ascent; if inhibited, the uterus retroverts and prolapses. In the treatment of such uterine displacements, the sacro-uterine ligaments must be strengthened or a cure is not possible. To do this the lesion, often an innominate subluxation, must be reduced.

According to Quain, the visceral branches of the anterior sacral nerves that innervate the **prostate gland,** are secretory in character. The gland has a secretion which has to do with thinning the seminal fluid. **Prostatorrhea** so often mistaken for spermatorrhea, is a result of an abnormal activity of this gland. If the lesion is irritative, secretion of the prostate will be increased; if paralytic, it is lessened. The prostate, in all probability, receives vaso-motor and motor impulses in part, from the sacral nerves. If this is true, a lesion of the innominate may produce motor and vascular disturbances of the gland. The **vesicle seminales** and vas deferens also receive some impulses from the spinal cord by way of the pelvic plexus.

An **articular branch** from the anterior sacral nerves passes to the hip-joint. Disturbances of the joint may be the effect of an innominate lesion on account of disturbance of this nerve filament.

The **great sciatic**, is the principal nerve coming off from the sacral plexus, in fact it seems to be a continuation of the plexus. It is composed of two parts, the one portion going to form the external popliteal, the other, the internal popliteal. The former is derived from the anterior division of the fourth and fifth lumbar and first and second sacral nerves; the latter, from the anterior divisions of the fourth and fifth lumbar and the first, second and third sacral nerves. These parts unite to form a thick band which passes out of the pelvic cavity through the great sacro-sciatic foramen in relation with the pyriformis muscle. It then passes through the buttocks into the thigh in the hollow between the great trochanter and the tuberosity of the ischium. The upper part is covered by the gluteus maximus and is most superficial while in relation with the trochanter and tuber ischii. In the thigh, it lies on the adductor magnus muscle, and terminates at or near the popliteal space, where it divides into two branches, the internal and external popliteal.

The internal popliteal continues as the posterior tibial, which in turn divides into the internal and external plantar.

The external popliteal divides into the anterior tibial and musculo-cutaneous. This nerve is chiefly **motor** and **sensory,** although it has vaso-motor, secretory and trophic functions. It supplies motor impulses to some of the muscles on the posterior aspect of the thigh and practically all those below the knee. It supplies sensation to about the same areas; also supplies the various articulations of the lower limb. It is vaso-motor and trophic to the same areas and secretory to the sweat glands of the lower part of the thigh, leg and foot.

This nerve is affected by an innominate lesion (1), because of the relation of its roots to the sacro-iliac articulation, and (2), because of contracture of certain muscles and tissues that are in relation with this nerve and would be affected by the lesion and (3), because of the vascular changes in the nerve that are produced by the lesion.

The lesion may stimulate or inhibit the nerve filaments or roots that go to form this nerve. Only a few of these filaments may be affected, or in marked innominate lesions, many may be disturbed. This accounts for the variable effects on this nerve and its branches, from a lesion affecting it. If the lesion is irritative, that is if it produces a stimulating effect on this nerve, all or only some of its functions will be disturbed, this depending on the degree and length of the stimulation.

The **motor effect** varies in different cases, but cramping of the leg or foot is fairly common. "Morton's toe" is an example. Contracture of any of the leg muscles may result. If the nerve were inhibited by the lesion, there would be relaxation of some or all of the muscles supplied by it. Atrophy is present, and if the lesion is extensive, the relaxation and weakness are so marked that the function of the limb is almost completely lost.

The **sensory effects** of a lesion of the innominate disturbing the great sciatic nerve, are most common and pronounced. If the lesion is irritative, sciatica in some form is the usual effect. This disease is characterized by pain in and along the course of the nerve, which is more or less severe. Inflammation is usually present. The disorder follows soon after an injury to the innominate, sometimes as an ache, sometimes as an acute pain. Any movement of the hip increases the pain, which is so excruciating in some cases that the patient is scarcely able to endure it. The patient favors the affected side and in chronic cases, a scoliosis develops,

called sciatic scoliosis, in which the concavity is directed toward the affected side. The pelvis is usually tilted, but this is the result of the subluxation as often as the result of posture.

Sciatica is diagnosed by discovering tenderness of the sciatic nerve at the points at which it is most superficial. These points are (1), a point about midway between the great trochanter and the tuberosity of the ischium, and (2), the popliteal space, the first named being the more important of the two. The innominate lesion produces sciatica by directly irritating the roots that go to form the sciatic nerve, which roots **cross and are bound down to the sacro-iliac joint.** In acute cases in which the pain is intense, the nerve roots are considerably injured. In the milder and more chronic forms the subluxation is not so marked, but the long continued irritation produces the chronic sciatica. The author recognizes other causes of sciatica, but the most common and important one is the innominate lesion.

This subluxation may disturb the function of the nerve by causing contracture of muscles in relation with the nerve, viz., the pyriformis and the hamstring muscles. Pressure is exerted directly on the nerve by contracture of these muscles, and if very marked or continued for any great length of time, the nerve becomes irritated, congested or inflamed and the condition is called sciatica. In all cases in which the disorder is well marked there is a perineuritis, while in ordinary simple cases there is only a congestion of the nerve and the tissues immediately surrounding it.

Other sensory effects result from an innominate lesion, such as "neuralgia" of different parts of the leg and foot, cramping of the lower limb, numbness, itching and burning sensations usually in the bottom of the foot. This is called erythromelalgia or red neuralgia, of the feet. As stated in the discussion of the effect on this nerve of a lesion of the fifth lumbar, any sensory, motor or trophic, or even vaso-motor disturbance of the lower limb may be the result of an interference with the functioning of the great sciatic nerve. An innominate lesion is the most frequent and important of causes that affect this nerve.

*"Referred pains are quite common, and are probably due to the pressure or pull upon the nerves in the sacral region. The lumbo-sacral cord passes directly over the upper part of the sacro-iliac articulation, and it is easy to see that a slight displacement or the thickening

*Goldthwait, Loco citra.

FIG. 87.—Showing a twisted pelvis slightly exaggerated. (From photo). The waist line on the right was almost obliterated while that on the left was deepened.

or nodes resulting from disease might cause pressure upon this nerve trunk. Undoubtedly the pressure or irritation of the nerve received in this way causes many of the pains referred to the leg. They may be referred to any part below the seat of the trouble, to the thigh, the hip, the calf, or down the back of the leg following the sciatic distribution. That the nerves are pressed upon or irritated is not to be wondered at when the anatomy is considered. In fact, in any displacement that may occur, or in the hypertrophic arthritic thickening, the edge of the bone is so exposed that pressure or irritation of the nerve is almost to be expected."

Disturbances of the sciatic nerve may cause congestion of the lower limb, varicose veins, ulceration, caries, or any pathological vascular or trophic effect, since the function of the nerve is in part vaso-motor and trophic. Pathological sweating of the feet may also be a result of an innominate lesion producing a disturbance of the great sciatic.

Hilton, in speaking of the sacro-iliac joint, says that affections of it may be mistaken for hip-joint disease. He says, "it is impossible to look at the form of the sacrum—its wedge-shape, the broad or massive part of the wedge being above—or to regard the extent of the articular surfaces of these bones and the strong ligaments which fix them together, without percieving that great strength is a part of their natural function. If any disease should occur at the sacro-iliac joint (and I would add subluxation,) I think it will be apparent what the symptoms may be. If a patient should have disease there, he could not sit very comfortably even on the sound side, because then the whole weight of the body would be transferred through the medium of the spine to the sacrum, and thence produce pressure upon the articular structures of the joint, which would, if diseased, produce pain. Nor could the patient stand upright without great pain." He further mentions the effect on the obturator, great sciatic and superior gluteal nerves and the psoas magnus muscle. A great many cases of supposed hip-joint disease are in reality a sacro-iliac subluxation.

The **obturator** nerve, on account of its relation to the sacro-iliac joint, is sometimes affected by a lesion of the innominate. Pain in the hip, but especially on the inner side of the knee on the same side, is the most common effect.

In innominate subluxations, everything attached to the bone is more or less affected, because in the production of the lesion the move-

Fig. 88.—Lateral curvature of spine. Note effect on contour of hips. (From photo.)

ment of the bone was carried beyond the normal range of movement. The muscles attached to the innominate are noted for their size and strength, which factor must be considered in the production of innominate lesions. The muscles affected most are in front, the rectus femoris and sartorius; on the side, the glutei and iliacus; and inferiorly, the hamstring muscles. If the bone is rotated back and up, the most common form of lesion, the anterior muscles are put on a tension. This produces a stiffening of the limb followed by impaired movement, and in many cases, an interference with the return circulation from the lower limb. Varicose veins sometimes complicate such a displacement. If the bone is displaced upward it will affect the iliacus. The muscle often becomes thickened, and on this account, leads to an error in diagnosis in that it is mistaken for some form of tumefaction of the pelvis. This condition produces a pain or drawing sensation referred to the iliac fossa. The glutei muscles, when put on a tension, interfere with the position of the coccyx and the movement of the lower limb. In lesions in which the ischium is displaced upward or backward, the hamstring muscles are put on a tension. This produces (1), pressure, directly or indirectly, on the great sciatic nerve, and (2), interferes with extension of the leg and flexion of the thigh and both assume a state of partial flexion. In lesions in which the posterior spines and crest in relation are displaced backward or downward, the erector and multifidus spinæ muscles are put on a strain which, when continued for a while, produces an ache in that region. In addition to the muscular effects the various ligaments are disturbed, not only those of the sacro-iliac joint, but the uterine ligaments, the broad and ovarian. All these tissues are affected by the lesion, the result of which is a thickening of the parts and a sense of pulling or drawing.

The **contour of the pelvis and hips** is changed by the innominate lesion, one side or hip becoming larger and higher than the opposite one. This is more common and noticeable in the female than in the male. This unsymmetrical condition may in turn affect the spinal column and often a well defined scoliosis develops.

The **length of the lower limb** is usually, although not necessarily, affected. In recent and typical cases, there is a slight shortening of the limb although the opposite condition may exist.

The **mobility of the hip-joint** is lessened and the patient complains of a neuralgia or "rheumatism," as it is most frequently diagnosed by

the layman. The limb may ache or become congested and edematous.

The **sensory** disturbances come most frequently from the effect on the sciatic nerve. The congested condition, from obstruction at or below the saphenous opening; the edematous condition from obstruction to the lymphatic return. Many a case of pain along the thigh, varicose veins or congestion of the lower limb, or marked edema of the ankle, is due to a lesion of the innominate on the affected side.

In all innominate lesions there is some change at the symphysis pubis. It may not be enough to be palpated but in many cases it is, and it is a good plan to examine, what Dr. Still has so often called the "cross bones," for tenderness and irregularity.

In the correction or reduction of innominate lesions, the limb should be used as a lever and on this account care should be taken not to underestimate the amount of force it is possible to exert when using it as such.

THE SACRUM.

The **sacrum,** so-called by the ancients because it was regarded as the sacred part of an animal and was offered as a sacrifice, is a large curved triangular bone formed by the union of five separate vertebræ. It is joined to the innominate by the sacro-iliac articulation, hence displacements of this bone affect the joint and the adjacent structures in a way similar to that of an innominate lesion. The sacrum has a possible movement; that is, one of antero-posterior rotation around the sacro-iliac articulation as a pivot. This takes place to a certain extent during parturition.

It is subject to displacement downward, forward, backward, or a combination of two or more of these; that is, rotation and torsion. It is placed at quite an angle with the spinal column, an angle of about 50 degrees. In subluxations of the sacrum this angle is changed, there is tenderness at its articulations and possibly irregularity. **Forward rotations** of the sacrum are diagnosed by prominence of the lower part and the angle. If the upper part is rotated forward, the lower part is brought into prominence and the sacro-coccygeal articulation becomes more angular. If the upper part is rotated backward the angle is lessened, the upper part is prominent, the lower part is almost on a line with the upper part. Descent is diagnosed by height of the innominata as compared with the spines of the lower lumbar vertebræ. In making a diagnosis

of a lesion of the sacrum consider (1), tenderness at the sacro-lumbar, sacro-iliac and sacro-coccygeal articulations, and (2), irregularity at one or all of these joints, height of innominata and angle or position of the sacrum. In addition to this consider the character of the symptoms, location of pain and history of injury to part.

The lesions of the sacrum come from causes that ordinarily produce innominate lesions and in addition, lumbar disturbances such as curvature; falls in the standing posture, the superimposed weight of the body

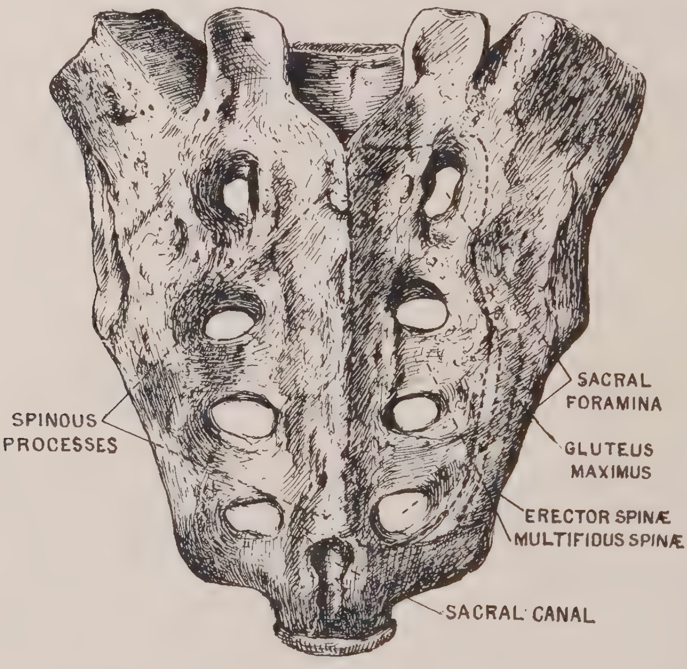

Fig. 89.—The posterior aspect of the sacrum. Note the superior articular facets and the arrangement of the foramina.

driving the sacrum downward; and direct injury or certain occupations that necessitate the patient's sitting bent over a desk or working in a stooped posture.

The effects on the sacro-iliac joint are the same as those from an innominate lesion. The effects on the sacro-lumbar articulation are practically the same as those from a lesion of the fifth lumbar vertebra.

The sacro-coccygeal articulation will be affected and will be considered in the study of lesions of the coccyx and their effects.

The structures attached to the sacrum will be more or less affected by a lesion or partial displacement of it. The glutei and erector spinæ muscles and the great sacro-iliac and sacro-sciatic ligaments are attached. Anteriorly the pyriformis is the principal muscle, and the sacro-uterine the most important ligament. If the sacrum becomes more nearly vertical, as is often the case, all these structures will be

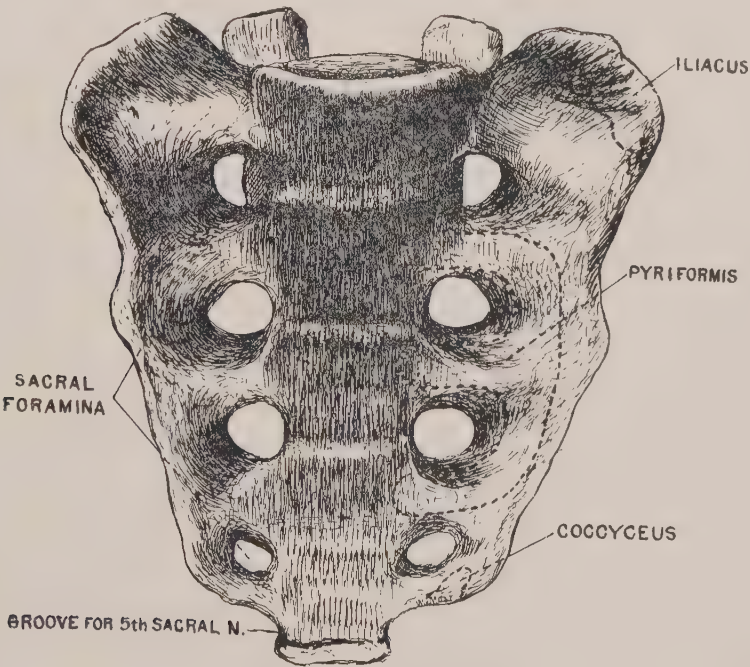

FIG. 90.—Anterior view of the sacrum.

changed. If the change of position of the sacrum is gradual, there will be few, if any, indications or disturbances other than a weakening of this part of the back. The change in the sacro-uterine ligaments usually affects the uterus. The downward displacement of the sacrum or a forward rotation of its upper part, lessens the size of the inlet of the true pelvis, that is the true internal conjugate diameter of the inlet is lessened so that parturition is difficult on account of delayed engagement

of the fetus. In rachitic subjects, the promontory is bent downward, often to such an extent that delivery is impossible without resorting to an operation.

In subluxations of the sacrum, the **contour of the spinal column** is changed. The more nearly vertical the sacrum, the more posterior the lumbar spine and the more nearly straight the entire column. If the sacro-lumbar angle is lessened, the anterior curve of the lumbar region is increased. There may be muscular effects. If the lesion is irritative on only one side, the contracture of muscles on that side will draw the spinal column to that side.

The condition of the spinal column has a great deal to do with the position of the sacrum. A posterior lumbar spine will produce a straight sacrum. The way a great many people sit is responsible for sacral deviations. They sit on the sacrum instead of the tuber ischii, and the lumbar spine is forced into a position of posterior curvature and the sacro-lumbar angle becomes almost a straight angle. This continued, will lead to a change in position of the sacrum, which is pathological.

*"The lateral deformities or deviation of the body to one side, due to the displacement of the bones on one side and not on the other, are common. The onset may be sudden. The so-called "stitch" in the back following strain or overwork, is in most instances, due to the slipping of these bones, and in these cases the lesion represents a definite sprain, the severity of the symptoms depending on the severity of the injury as with sprains of other joints."

A displacement of the sacrum will affect the **sacro-coccygeal** articulation and produce symptoms and signs that are ordinarily attributed to a subluxated or dislocated coccyx. The sacro-coccygeal articulation is formed by the articular facets of the last sacral and first coccygeal vertebræ. The articular surface of the first coccygeal segment is oval shaped and faces forward and upward. From the upper part two cornua or projections pass upward and inward and are connected with the sacral cornua by the sacro-coccygeal ligaments. A foramen is formed by these through which the fifth sacral nerve passes. This articulation is a hinge joint, its movements being antero-posterior. These movements are pronounced in parturition and defecation. The contraction of the levator and sphincter ani muscles causes it to be drawn forward; contraction of the gluteus maximus, drawing it backward and to one side.

Goldthwait, Boston Med. and Surg. Journal, 1905.

Lesions at this joint result from displacement of the sacrum or coccyx. Trauma and strain are responsible for many cases, but muscular contraction is an important factor in the production of coccygeal subluxations. If the lower part of the sacrum is rotated backward, the sacro-coccygeal articulation or angle is affected and becomes more acute, since the tip of the coccyx is not displaced, but held in position by structures attached to it. If the sacrum is displaced downward the effect is about the same. Often this sort of sacral lesion is mistaken for an anterior luxation of the coccyx. In either case the sacro-coccygeal articulation is affected. In determining which is at fault, the sacrum or the coccyx, both should be examined for irregularity, tenderness and disturbances resulting.

In lesions of this joint the ligaments, first of all, would be involved, that is they are stretched and thickened as in a sprain of any joint. The muscles attached to the coccyx are affected more than those attached to the sacrum, since the coccyx is the more movable of the two and is the one displaced most in ordinary cases.

The **muscles** attached to the coccyx are the levator ani, coccygeus, external sphincter ani and gluteus maximus. Their function will be affected to some extent by the lesion. Contraction is a common sequel which is followed by rectal tenesmus and constipation, from a lessening in size of the lumen. Hilton, in speaking of this joint and the glutei muscles, says: "It must be obvious that if the sacro-coccygeal articulation or the coccyx itself be inflamed, and the gluteus maximus be used to any extent in the act of elevating the body from the sitting posture or in sitting down, or in rapid progression, the coccyx or sacro-coccygeal articulation must be much disturbed. Hence, although the patient may be able to walk gently, slowly, and carefully, yet on attempting to stride out he suffers considerable pain from the disturbing influence of the gluteus maximus. . . . . During defecation, this muscle (speaking of the external sphincter ani) and the levator ani contracting would tend to disturb or displace the coccyx and pull it away from the sacrum. Some of the symptoms of which such patients generally complain are thus explained." I would offer in addition to this, cases in which there is a partial displacement of the coccyx, which is by far more common than disease of the joint, in which the symptoms would be similar to, or almost identical with, those outlined above.

The **nerves** in relation with this joint and which supply the tissues

in relation are (1), the pudic, the perineal branches; (2),posterior branches of the lower sacral nerves; and (3), the sacro-coccygeal. All of these send sensory filaments to the perineum. The effects of a lesion involving these nerves would then be sensory in character. Pruritus ani is the most common sensory effect. Sexual passion is increased, sometimes to a pathological degree, which is explained by the disturbance of the pudic nerve or one of its branches. Pain in the perineum is not unusual, this resulting from a displacement of the coccyx or abuse of the function of the pudic nerve.

The coccyx, when displaced, often produces disorders by **pressure or traction on,** the tissues attached and the bowel is most affected. If displaced forward the pressure may obstruct the veins of the rectum, thus producing hemorrhoids, or it may affect the nerves in relation, producing effects varying with the degree of pressure and the nerves involved. This displacement will interfere with defecation and parturition, and especially if anchylosis of the sacro-coccygeal articulation has taken place. Falls and blows on the coccyx are most responsible for its forward displacement. Such injuries dislocate the coccyx and force it forward into the rectum. The point of the bone mechanically obstructs the lumen of the bowel and presses on important structures in relation, viz., the hemorrhoidal veins, nerves and arteries, thus almost any disease of the part, such as hemorrhoids,ulceration, constipation, diarrhea and painful affections, may result. The displacement may be at the sacro-coccygeal articulation but more commonly at the last coccygeal joint, and on rectal examination the tip of the coccyx is found to be directed inward and the angle formed is very acute. The coccygeal nerves are affected by such a displacement. These nerves are sensory to the integument in relation and the anterior is motor to the coccygeus. **Coccydynia** is a result of this coccygeal lesion.

THE BACK AS A REGION.

The Back as a Region. The **surface markings** of this region are the median furrow, the spines of the vertebræ, especially the vertebra prominens and first dorsal, the trapezii muscles and the scapulæ. The spinal furrow is formed by two masses of muscles; the erector spinæ masses, which fill in the groove on the sides of the spinous processes, and the bottom is adhered to and conforms with, the spinous processes. The spines are most prominent in the upper and lower dorsal areas when

sitting erect, but most prominent in the lumbar region on flexion of the body. The outline of the trapezii muscles can ordinarily be distinctly seen. The scapula is quite prominent, its spine and inferior angle being the parts used as landmarks. The interscapular space varies in different individuals, the average distance being about five inches. When the arms are thrown backward the scapulæ touch, when thrown forward they (the inferior angles) are separated about twelve inches.

According to McClellan, "the most reliable **landmarks** for clinical purposes in this region are as follows: The third dorsal spine is about opposite the bifurcation of the trachea; the fourth dorsal spine indicates the position of the base of the heart, while the eighth dorsal spine corresponds to the lower borders of the lungs, which, when fully expanded, follow the upper borders of the eleventh ribs. The second lumbar spine is opposite the termination of the duodenum and also opposite the commencement of the cauda equina within the the spinal canal. The fourth lumbar is opposite the bifurcation of the aorta."

The **integument** over the shoulders and upper part of the back is quite thick and closely adherent to the fascia beneath. On this account and that of friction from clothing, boils and carbuncles often form in this area, since the vitality is poor and the circulation not good. The skin of the lower part of the back is not quite so thick and becomes thinner from the spine outward. Few sebaceous glands are in the lower part, while many are located in the upper part, especially over the scapulæ. This leads to the formation of pimples on the upper part of the back and shoulders. The **sensibility** of the integument is less along the spine than at the sides of the thorax. The integument of the back is innervated by the posterior divisions of the various thoracic nerves, the internal branches of the upper six and the external branches of the lower six, supplying it.

The skin may be **pigmented** from deposits in it from jaundice, or from friction. If the spinous processes in the lumbar region are yellowish, it is indicative of a posterior condition with friction from the clothing or the backs of seats. Leucoderma is present in some cases, being well marked along the back. In some diseased conditions dermography is possible. The writer has seen cases resulting from a "going in" of the rash in measles, in which the least friction would raise a large welt which at first was white, then becoming congested and red, lasting for several hours.

In the examination of the back, it is well to make a test for the capillary reflex. This is done by pinching up the skin. This, in the normal patient, immediately produces a red area corresponding in size to that pinched. If this reflex is slow in responding to the test, or does not at all respond, it is suggestive of a lack of red blood corpuscles as in anemia. If the redness remains for quite a length of time, it is suggestive of an impairment of the nervous system and especially of disorder of the meninges of the cord. The tache meningeale of spinal meningitis is an example.

To the osteopathic physician, the most important part of the human body is the **spinal column.** By its changes in contour and condition the various visceral diseases can be diagnosed, in most cases. **I believe that every disease is characterized by external changes or signs,** and I further believe that **every chronic visceral disorder is manifest by changes in the spinal column that can be, by the practiced eye and touch, readily interpreted.** In short, there are **various signs** along the spinal column **that point out the weakened or diseased parts of the body.** This method of diagnosing diseases, that is by noting these spinal changes, is distinctly osteopathic, and I believe the time will come when it will become such an exact science that the **character of the spinal change or lesion is diagnostic not only of the viscus affected, but the way it is affected.** On account of the importance of the spine in diagnosis, particular study of it should be made, as to contour and condition, and the various conditions that change them.

In examining a normal spine note that the spinal furrow is of about equal width and depth along its entire course, being slightly wider in the upper thoracic area and slightly deeper in the upper lumbar region than elsewhere; the spines are regular and in line; that there are four curves, the anterior cervical, posterior upper dorsal, anterior lumbar and posterior sacral; that the seventh cervical and first dorsal spines are large, the spines of the thoracic region small and oblique, while the lumbar spines are largest. The **mobility** is good and most marked at the dorso-lumbar articulation. The normal contour depends on the above named curves and the development of certain muscles. The spine of a new-born baby is about straight. When the child begins to sit erect it forms one continuous posterior curve, and when the child begins to sit, stand and to walk, the curves begin to form. Eisendrath says: "When the infant begins to sit up, the weight of the head and shoulders and the

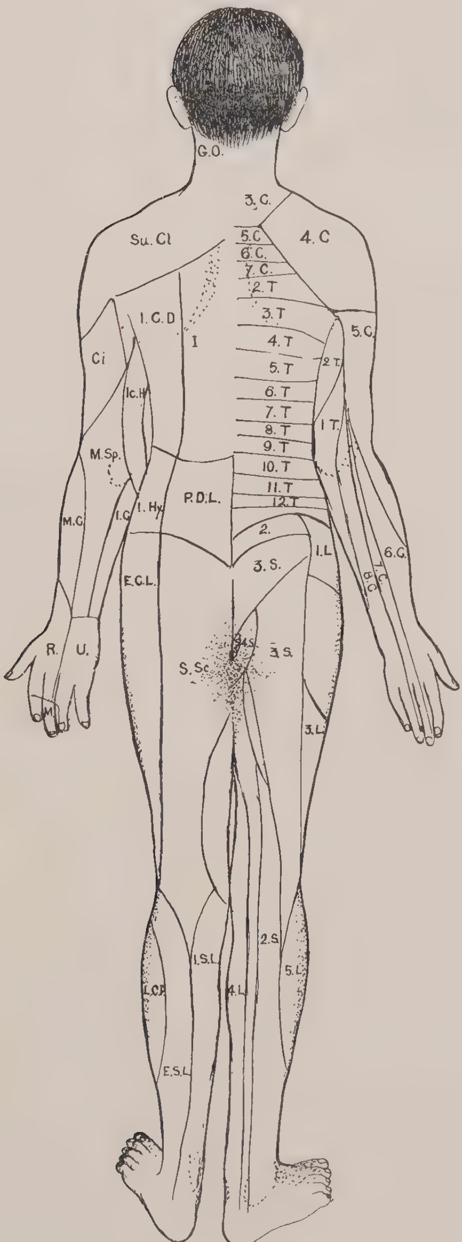

FIG. 91.—Showing the sensory innervation of the posterior aspect of the body. (After Eisendrath).

forward traction on the part of the viscera cause the development of a backward curve or kyphosis which extends over the whole spine. With the effort of the child to hold up its head the cervical portion of the spine gradually bends forward (lordosis). The third curve appears when the child begins to walk. In order to maintain the upright position the child uses its back and gluteal muscles. At the same time the pelvis is inclined downward, thus throwing the center of gravity of the body further back. In order to compensate for this the lumbar portion of the spine is bent forward resulting in the above referred to, lordosis of that region. These curves are not well marked until the seventh year, and can be entirely obliterated by traction upon the child's head."* These curves are maintained in the adult to a great extent by the intervertebral discs which are most developed in the lumbar region where movement is quite free. These discs are very elastic and the elasticity of the spine is due almost entirely to them. The natural curves of the body are the anterior and posterior, the least lateral deviation being abnormal.

The **muscles** that go to make up the normal contour are the erector spinæ, latissimus dorsi, trapezius and rhomboïdei; at least these are the most important. The normal contour varies with the degree of development of these muscles and the degree of curvature of the spine. Certain occupations increase the curves and still the spine is normal. In occupations in which the patient has to stoop a great deal, the posterior thoracic curve increases and still the contour is, as a rule, normal for that individual.

The **functions** of the spinal column are to **protect the spinal cord** and its membranes and **to permit the spinal nerves to emerge without injury** in all normal movements of the spine, to furnish a **fixed point** for action of muscles that move the body, and to **support** the head and trunk. If the contour is changed, any or all of these functions may be impaired, the most common result being the disturbance of the spinal cord, its membranes, and the nerves branching from the cord. Change of contour is of great importance to the osteopathic physician, for upon these changes is the diagnosis best made in many cases and the cause of disease ascertained. The effects of changes in contour on the spinal nerves may be overlooked or an error be made in diagnosis unless it be recalled that the segment that give rise to these nerves, their points of exit and the level of the corresponding spinous processes vary in different regions. The description given by McClellan is as correct as any.

*Clinical Anatomy, Eisendrath, P. 488.

He says: "There is no means of foretelling the absolute relative positions of the origins of the individual spinal nerves from the spinal cord but they may be approximately considered to be as follows: Collectively, the eight cervical nerves arise between the medulla oblongata and the cord opposite the spine of the sixth cervical vertebra. Individually, the first cervical nerve arises at the interval between the margin of the foramen magnum and the atlas vertebra, the second and third cervical nerves arise opposite the axis vertebra, while the fourth, fifth, sixth, seventh and eighth cervical nerves arise respectively opposite the bodies of the third, fourth, fifth, sixth and seventh cervical vertebræ. Collectively, the upper six dorsal nerves arise from the cord between the spines of the sixth cervical and fourth dorsal vertebræ. Individually, the first, second, third and fourth dorsal nerves arise respectively, opposite the intervertebral discs below the seventh cervical and the first, second and third dorsal vertebræ, while the fifth and sixth dorsal nerves arise opposite the bodies of the fourth and fifth dorsal vertebræ. Collectively, the lower six dorsal nerves arise from the cord between the spines of the fourth and eleventh dorsal vertebræ; individually, they arise opposite the bodies of the sixth, seventh, eighth, ninth, tenth and eleventh vertebræ. Collectively, the five lumbar nerves arise from the cord between the eleventh and twelfth dorsal spines. Individually, the first, second and third lumbar nerves arise opposite the body of the twelfth dorsal vertebra, and the fourth lumbar nerve arises opposite the intervertebral disc between the twelfth dorsal and first lumbar vertebræ. The fifth lumbar nerve, the five sacral nerves, and the coccygeal nerve all arise from the conus medullaris opposite the body of the first lumbar vertebra, which corresponds to the spines of the last dorsal and first lumbar vertebra." By referring to the above and recalling the obliquity of the spines in the various regions, the lesion can be located without much trouble, in case of injury to the spinal cord or subluxation of a vertebra that produces pressure on a spinal nerve at its exit.

The **tips of the spinous processes** are used as **landmarks** for locating various structures. Some of these landmarks have been given. Deaver gives in addition: "The sixth cervical spine corresponds to the highest level of the apices of the lungs. The third dorsal spine lies opposite the point where the aorta approaches the spinal column, the highest level of the lower lobes of the lungs and the bifurcation of the trachea. The ninth dorsal spine marks the level of the cardiac orifice of the stomach

and the upper limit of the spleen. The tenth dorsal spine locates the lowest level of the bases of the lungs and the level at which the liver reaches the abdominal walls posteriorly. The eleventh dorsal spine locates the lower limit of the spleen, the position of the suprarenal capsule and the upper border of the right kidney. The twelfth dorsal spine is on a level with the lowest part of the pleuræ, the aortic opening of the

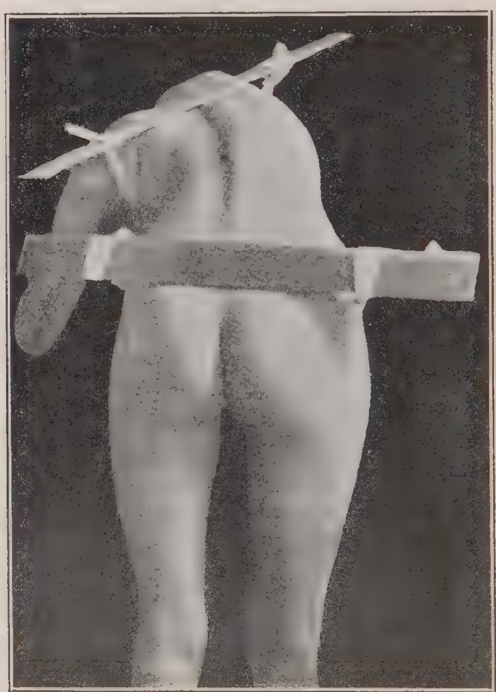

FIG. 92.—Model with spine flexed and bent to the left. The boards show the planes of chest and pelvis. The boards marking the chest, have rotated backward on the convex side of the curve. (Lovett).

diaphragm, and the pylorus. The spine of the first lumbar vertebra is situated opposite the renal vessels, the pelvis of ureter, and the pancreas. The second lumbar spine lies opposite the end of the spinal cord, the third portion of the duodenum, and the receptaculum chyli. The third lumbar spine is found just above the level of the umbilicus and below that of the lower border of the right kidney. The fourth lumbar spine

is located opposite the bifurcation of the aorta and the highest part of the crests of the ilia. The fifth lumbar spine marks the origin of the inferior vena cava. The third sacral spine lies opposite the termination of the sigmoid flexure and the lowest level of the spinal membranes. The tip of the coccyx marks the junction of the first and second portions of the rectum."

The movements of the spinal column are of great importance to the physician in that lesions of the vertebral articulations are indicated best by disturbances of these movements. A spinal column in which

Fig. 93.—Experimental double curve (right dorsal, left lumbar) produced in the model by elevating the right side and having the model twist the upper part to the left. (Lovett).

the movements are normal, is as a rule a normal one and if there are visceral disorders they are due to other causes. These movements are distributed amongst all the vertebral articulations, that is there is movement at every articulation in the normal spine. In the examination of patients, this point is often overlooked on account of the compensatory hypermobility of other articulations.

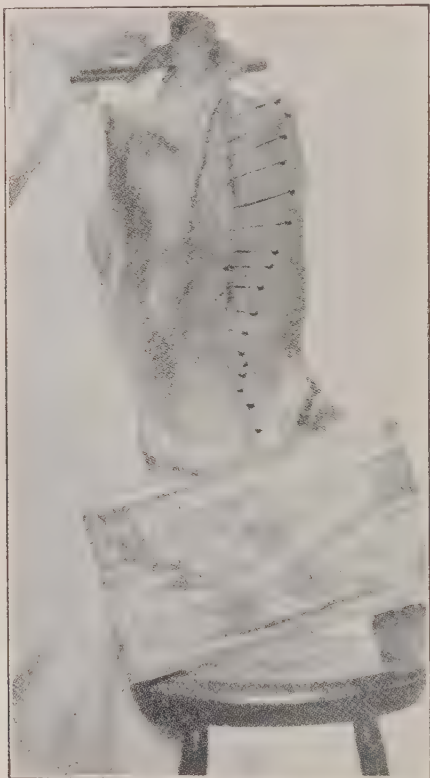

Fig. 94.—Experimental double curve (right dorsal, left lumbar) produced in the cadaver by elevating the right side of the pelvis and twisting the upper end of the spine, face to the left. (Lovett).

These movements are produced by muscular contraction and by gravity. In flexion, the muscles of the front of the column are active, while in extension the muscles of the back contract. The muscles that

produce extension are stronger than those that produce flexion, hence in spasms, there is a drawing back of the body as in opisthotonus. Gravity begins to assist just as soon as the body is drawn away from the perpendicular by the muscular contraction.

The movements are most free in the cervical and lumbar articulations and in these regions, at the atlanto-axoidal and dorso-lumbar joints. They are considerably less than one would suppose when the extent of the spinal movements is considered, the explanation being

FIG. 95.—The right side of the pelvis of the cadaver is raised and the upper part of the spine falls to the left, making a lateral curve convex to the right. (Lovett).

that much of the supposed movement takes place at the hip-joints and the lumbo-sacral articulation. For example, in flexion the greater part of the forward movement is in the hip-joints while if you ask the patient to bend to the side, the pelvis will be tilted to the opposite side, this exaggerating the apparent lateral bending.

There are essentially three movements of the spinal column: flexion or forward bending, extension, or backward bending, and lateral bend-

ing with rotation. Flexion and extension are most free in the cervical and lumbar regions while rotation and lateral bending are most marked in the thoracic, the atlanto-axoidal articulation being excepted.

Flexion in the cervical region is not very marked since much of the movement is between the occiput and the atlas, and the second cervical

Fig. 96.—The right side of the pelvis of the model is raised and the upper part of the spine is carried to the right, making a lateral curve convex to the left. (Lovett).

vertebra or axis. Ordinarily the anterior curve only can be obliterated. In hyperextension the normal curve can be increased. In side bending, the movement is fairly well distributed amongst all the articulations but

the greater part is in the upper part of the neck. There is rotation of the bodies of the vertebræ to the opposite side, that is, toward the convexity of the curve.

In the thoracic region, there is little flexion or extension, the principal movement being that of rotation which seems to be a part of the

FIG. 97.—The right side of the pelvis in the cadaver, is raised and the upper part of the spine firmly held, making a lateral curve with convexity to the left. (Lovett).

movement in side bending. This movement is practically the same as that in the neck, the bodies of the vertebræ rotating to the convexity, and the spines toward the concavity of the curve. This should be remembered in the treatment of scoliosis since the opposite rotation of the spines would be expected on first examination. The greater the degree

of flexion of the body at the time of the side-bending, the greater the degree of rotation, and the higher it occurs in the spine. Side-bending in the erect posture is accompanied by rotation low in the spine which is best marked at the dorso-lumbar articulation.

Flexion and extension are the principal lumbar movements, rotation and side-bending being slight. These movements are not so free as one

Fig. 98.—Model flexed and bent to the left. The card-board indicators have turned to the left. (Lovett).

would at first think on account of the free movements of the hip-joints and the lumbo-sacral articulation. *Lovett arrived at the following conclusions after careful investigation: "(1) In the lumbar region flexion

*Boston Med. and Surg. Jour. p. 355, Vol. CLIII.

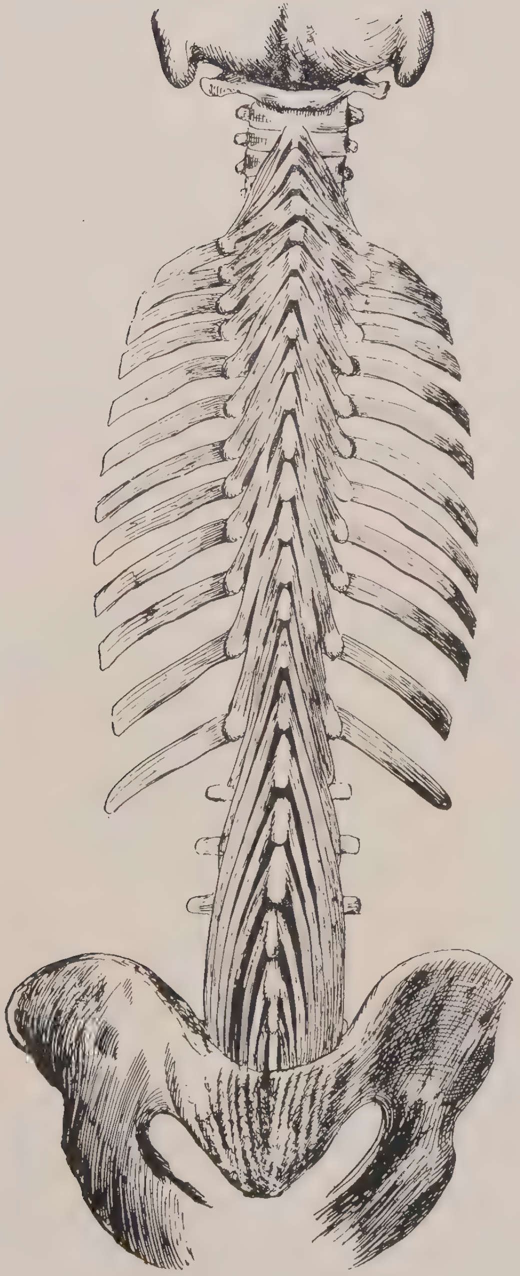

Fig. 99.—Showing the multifidus spinæ muscle. This muscle is involved in scoliosis. Its contraction produces lateral flexion with rotation to the opposite side.

diminishes mobility in the direction of side-bending and rotation, and extreme flexion seems to lock the lumbar spine against these movements. (2) In the dorsal region hyperextension diminishes mobility in the direction of side-bending and rotation. Extreme hyperextension seems to lock the dorsal spine against these movements. (3) In flexion

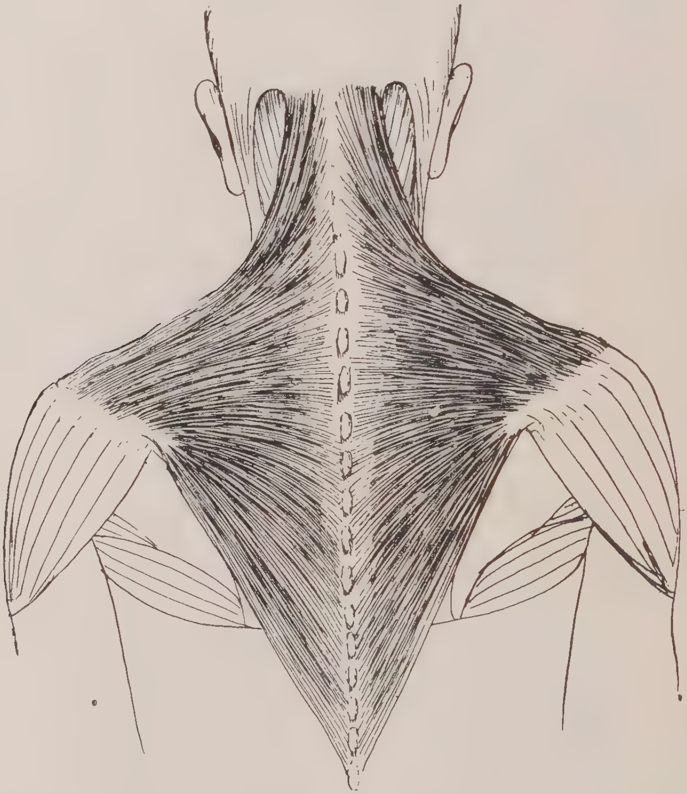

Fig. 100.—The trapezii muscles. In colds of the upper respiratory tract, the parts covered by these muscles are always tender on pressure.

of the whole spine, side-bending is accompanied by rotation of the vertebral bodies to the convexity of the lateral curve, the characteristic of the dorsal region. (4) In the erect position and in hyperextension of the whole spine, side-bending is accompanied by rotation of the ver-

tebral bodies to the concavity of the lateral curve, the characteristic of the lumbar region. (5) The dorsal region rotates more easily than it bends to the side, whereas the lumbar region bends to the side more easily than it rotates. (6) Rotation in the dorsal region is accompanied by a lateral curve, the convexity of which is opposite to the side to which the bodies of the vertebræ rotate."

Abnormal changes in contour of the back are due to **muscular contractures, curvatures, tumors, enlarged viscera, certain occupations** and some forms of **visceral diseases.** The muscles most commonly involved are the erector spinæ mass, trapezius, quadratus lumborum, serratus magnus and the rhomboid muscles. If contracture of any of these muscles takes place, it becomes enlarged and prominent and has a tendency to draw the spine to that side. Relaxation of any one would make it appear that the opposite one was contractured or enlarged. Contracture of the erector spinæ mass of muscles produces enlargement on that side; relaxation or atrophy has the opposite effect. The trapezius when contractured makes the suprascapular region more prominent. Relaxation of the serratus magnus causes the scapula on the same side to become prominent, that is, it becomes winged, thus changing the contour. If the rhomboids are also relaxed, the interscapular region is widened and the spine becomes flattened. If there is general spinal atrophy, the ribs become displaced downward, the normal curves of the spine are obliterated and the spinous processes become plainly visible.

Curvature of the spine is the most common and important of all the causes of change in contour of the back. By curvature of the spine is meant an abnormal bending or swerving of the spinal column, which is ordinarily accompanied by disturbance of function of that part of the spine, and of viscera and structures innervated by the nerves that are in relation with the points of the spine affected. Most curvatures start from a single lesion, that is, subluxation of a single vertebra or abnormal movement of one part of the spinal column on another. These lesions produce curvature either by interfering with the nutrition of that part of the spinal column, or by causing muscular atrophy or contracture. Muscular contracture from other causes often leads to curvature. Muscular atrophy produces curvature since the sound side is unaffected and the muscles unopposed, draw the spine to that side.

The size of the viscera in relation has to do with the contour of the spinal column, as is evidenced by curvature following a collapse of one lung. Faulty posture often leads to curvature, and unequal length of

the lower limbs, a tilted pelvis and diseases of the bones, as in rickets, are also responsible for many cases.

The forms of curvature vary from a slight flattening of the dorsal area to a well marked case of scoliosis. Posterior curves are most frequent in the lumbar, and are called kyphoses. An anterior curve is called a lordosis, and scoliosis is the name given to a lateral curvature.

The **kyphosis** is possibly the least harmful, compared with the extent or degree of variation, since the intervertebral foramina are enlarged rather than lessened by it. This form results most frequently from occupations involving the stooping posture or faulty methods of standing and sitting. A general spinal weakness is responsible for most cases coming under the last named class, and the patient no longer attempts to sit erect but sits with a marked posterior lumbar curve. If the patient by attempting to sit erect is unable to obliterate the posterior condition, it is a pathological kyphosis. Occupational kyphosis is seldom pathological, neither is the posterior curve is the upper dorsal region, from old age. Enlargement of the lungs, as in asthma, produces a kyphosis in the thoracic region. Disease of the body of the vertebra, as in tuberculosis of the vertebra, will produce an angular curvature commonly called Pott's disease of the spine.

In order for the spine to be curved abnormally far posteriorly, there must be a separation of the spines from thickening of the posterior part of the disc, partial flexion or compression of the bodies and anterior portion of the intervertebral disc, or all. In most cases there is simply a relaxation of the ligaments and muscles along the posterior aspect of the vertebral column, which weakens the supports and consequently the spine seeks a position of most ease, that is the patient sits in a semi-reclining posture. Such conditions are not in reality curvatures, but are indicative of weakness which will lead to curvature if not soon overcome. This weakening may be due to a single vertebral lesion or it may be a part of a general disturbance of nutrition, as in anemia, rickets or any disease in which the body is poorly nourished. Compression of the discs may be due to constant pressure on the anterior portion, or it may be due to disease or loss of elasticity of the disc on account of a vertebral lesion or injury. The body of the vertebra may be compressed, as in **Pott's disease,** thus producing an angular curve. The compression of of the disc and body of the vertebra is always present in pathological curves.

A kyphosis produces disease by interfering with the function of

the spine, structures attached, nerves and vessels in relation and viscera innervated by that area. A pathological posterior curvature weakens the spinal column, thereby interfering with the support of the head and body and attachments of muscles. This weakness is directly the result of mal-alignment of the vertebræ, mal-nutrition and changed relations of the muscles attached. On account of the change in position, the

Fig. 101.—Lateral view of a boy suffering with Pott's disease of the spine. Note the angular enlargement. The symptoms in this case were almost completely relieved but the deformity was not materially changed. (From photo).

structures attached will also be changed. This is not an important effect. The intervertebral foramina depend for their size on the amount of separation of the vertebræ. In pathological kyphosis the discs are usually thinned, from the pressure, to such an extent that these foramina

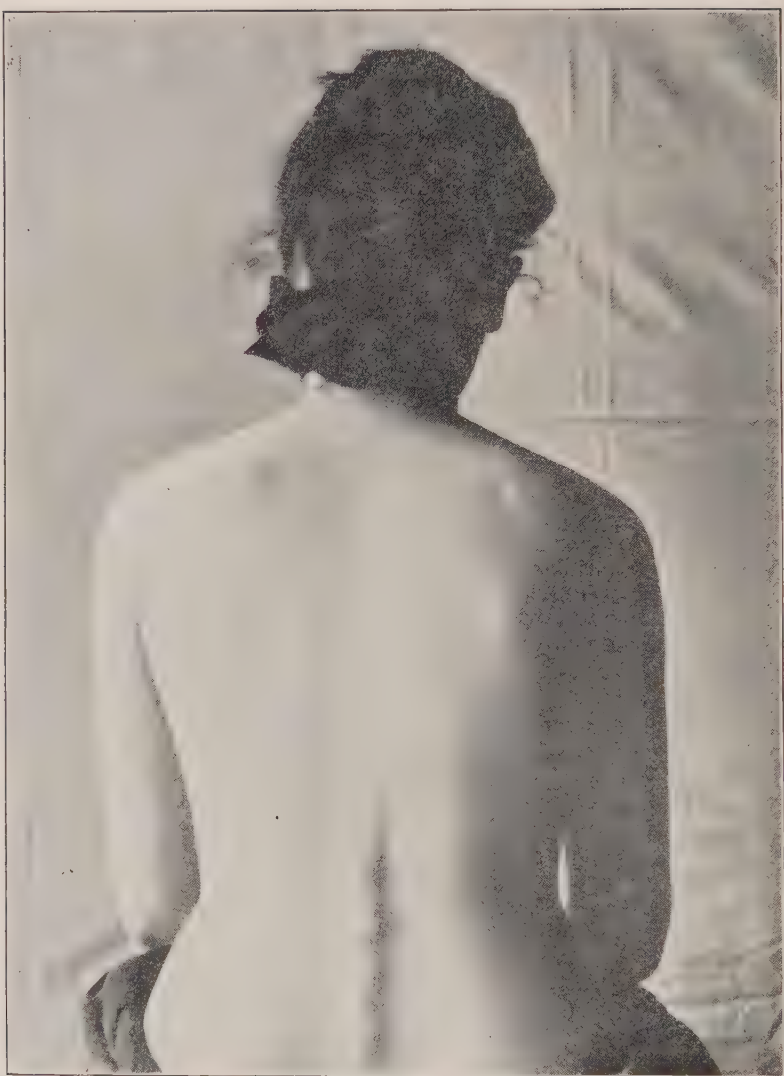

Fig. 102.—Posterior curvature of the lumbar region. (From photo). The patient had bowel and uterine trouble.

are lessened in size. In order to get this effect, the compression of the disc must be more marked than in lordosis. In cases in which the foramina are lessened in size, the blood-vessels are compressed and the passing of nerve impulses over the nerve interfered with. The effects vary with the degree of compression and the character and function of the parts innervated by these nerves.

Posterior curvature in the lumbar region is more often pathological than in other regions. One reasion for this is that it occurs most frequently in this region. The bowel (lower) and pelvic organs, especially the uterus in the female, are more frequently affected than other viscera. The impulses supplying these parts are partly or completely cut off and a form of paralysis of the parts follows. The curvature may be irritative, but is most commonly inhibitory, therefore there is lessened activity of the viscera supplied by the nerves affected. Kyphoses produce most of their effects by lessening the size of the intervertebral foramina, thus interrupting the passing of blood and nerve impulses through them. Pott's disease comes from an injury to the spine in a child who has a tubercular taint. The lesion weakens and lowers the vitality of the part to such a degree that a nidus favorable to the propagation of the tubercle bacilli, is formed. The body of the vertebra is honey-combed, sometimes breaks down and in many cases becomes ankylosed. When this takes place it is called the quiescent stage. If the case is seen soon after the primary injury, the condition can be cured. A very slight twist of the spine, a sudden though gentle push in the back, as school children are wont to do, are usually the initial injuries; in short, a **subluxation** or sprain of a vertebral articulation from some cause or other, is the cause.

In the treatment of a posterior curvature ascertain the primary lesion and correct it if possible. The things to be accomplished in order to effect a cure in an ordinary case are (1), restoration of elasticity to the intervertebral discs, this being done by restoring normal nutrition; (2), the regaining of normal tone to the spinal ligaments, and (3), restoring the vertebræ to their normal position. The first and second can be accomplished by repeated attempts at replacement of the displaced vertebræ, and certain exercises that build up the general strength. The third is usually accomplished gradually by developing ligaments and muscles, and by repeated attempts at replacement or straightening of the spine. It is well to ascertain whether or not the curve is pathological, or whether it is the effect, rather than the cause of the other disorders,

since a great many cases of supposed posterior curvatures are not real, but assumed, on account of spinal weakness.

Lordosis in a marked form, is most common in the lumbar region but in mild cases the dorsal region is the usual seat, this being not a real curvature but a flattening of the normal posterior curve in this region. Dislocation of the hip, whether congenital or acquired, also

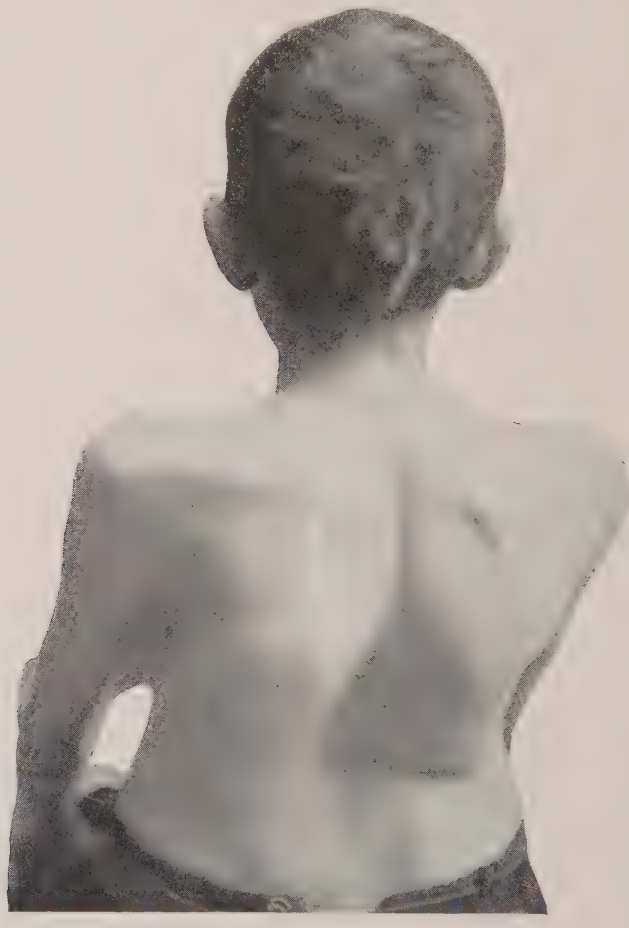

FIG. 103.—Showing contour of spine in a marked case of lordosis in lower thoracic and upper lumbar regions. These deformities usually start in children, from a lesion of a single vertebra. (From photo.)

FIG. 104.—Showing an anterior condition of the upper thoracic region. (From photo). Note the compensatory posterior curve in the lumbar region.

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hip-joint disease, are causes of importance. Malnutrition of the lumbar vertebræ and ligaments, will permit of an exaggeration of the normal anterior curve in that region. In pregnancy and obesity, the traction exerted on the lumbar spine pulls it forward and the throwing back of the shoulders to retain equilibrium, is another important cause. In Pott's disease of the dorsal vertebræ, a lordosis in the lumbar region forms as a compensatory curve. Injury to the lumbar articulations, especially the upper lumbar, by which the vertebræ are forced directly forward, often leads to a curvature on account of the weakness, change of position and malnutrition that so often follow such lesions.

In typical cases the discs are compressed, especially the posterior parts, the articular facets forced tightly together and the intervertebral foramina lessened in size. As a result, the functions of the spinal column, spinal cord, spinal nerves in relation and muscles attached, are disturbed. In addition to this the function of viscera, innervated from this part of the spinal cord, is nearly always affected. The greatest effect results from a lessening in size of the intervertebral foramina. This, as in kyphosis, interferes with the blood-vessels and nerves in the foramina. Atrophy of the spinal muscles is a fairly common sequel, while visceral disease is frequent in typical cases. The flattening of the thoracic spine, while not a typical lordosis, produces about the same effects.

Scoliosis or lateral curvature of the spinal column is the most common and important of all the spinal curves. It is defined by Walsham as a "complicated distortion in which the spine forms two or more lateral curves with their convexities in opposite directions, whilst the vertebræ involved in the curves are rotated on their vertical axes so that the spinous processes are directed toward the concavity of the curves." According to the same writer, "the immediate cause that underlies the formation of lateral curvature is the unequal compression of the intervertebral cartilages for long periods." I would add that malnutrition of a part of the disc from a vertebral subluxation or other injury, is one of the frequent and important of causes.

There are many **causes** of unequal pressure on the discs. Unequal length of the lower limbs will produce compensatory lateral curve in the spine. The unequal length may be real, as in hip-joint disease, dislocation of the hip, and fracture; or apparent, as in a twisted pelvis or in disease of a leg or foot which causes the patient to favor one side. Collapse of one lung, enlargement of the heart or one lung, or muscular con-

tracture or hypertrophy of muscles on one side, may produce scoliosis. Muscular contracture is usually secondary to spinal lesions, a tilted pelvis, or irritative disorders of viscera. Hypertrophy is due to certain occupations in which one side is used to the exclusion of the other, **faulty posture**, as is seen in school children attempting to write on a desk either too high

FIG. 105.—A right lateral scoliosis in a young girl brought on as a result of a lesion in the mid-dorsal region and faulty posture while attending school. (From photo).

or too low, and the carrying of heavy weights or loads by children. **Muscular atrophy** from effects of a vertebral lesion, spinal cord disease, non-use, or disease of membranes of the cord, permit the unimpaired muscles to draw the spine to the opposite side. Scoliosis is a common sequel to cerebro-spinal meningitis and other diseases, such as fevers,

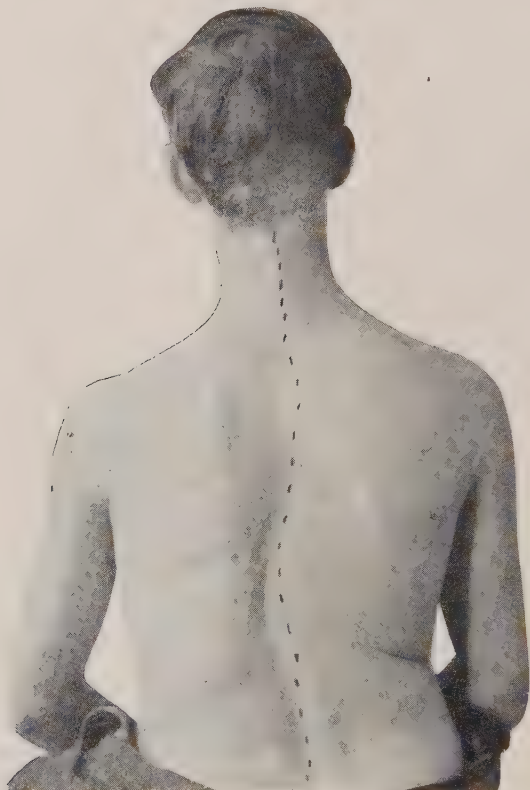

FIG. 106.—Showing a double scoliosis. Note the rotation, flexion line on the right and atrophy on the concave side. (From photo).

especially typhoid. In children the curvature starts from a wrench or strain of the spine in which the ligaments and muscles are irritated.

After all the essential cause of scoliosis is faulty posture. If there is a spinal lesion the patient assumes a position of greatest ease, that is,

FIG. 107.—Showing the contour of the spine in a case of simple lateral curvature in a girl seven years of age. Note the scapulæ, shoulders, hips and waist line. (From photo).

tries to protect the weakened or painful part. If from muscular disorders, the posture is the real cause of the unequal pressure on the discs. If from a diseased lung, the patient assumes an improper posture to protect the part as well as is possible. In recounting all the causes commonly mentioned as responsible for scoliosis, faulty posture is the immediate cause. This may be directly the cause or the faulty posture

may be the result of something else such as a fractured rib, in either case, the faulty posture is the immediate cause of the curvature.

The **effects** vary with the degree of curvature, rapidity of development, care that the patient takes of the spine, and methods of treatment. In all cases the spinal column is weakened and the functions disturbed. The spine is not only bent, but rotation of the vertebræ on a vertical axis takes place. In ordinary cases the body of the vertebra is rotated toward the convex side while the spinous processes point toward the concave side. This is probably due to the fact that the bodies of the vertebræ offer less resistance to the pressure and traction than do the articular processes, the posterior part of the vertebra being held more securely than the anterior part by the various spinal ligaments. "The theory, perhaps, most generally accepted is that of Dr. Judson, who believes that the rotation is due to the fact that the posterior portion of the vertebral column, being a part of the dorsal parietes of the chest and abdomen, is confined by the ligaments and muscles to the median plane of the trunk; whilst the anterior portion, projecting into the thoracic and abdominal cavities, being devoid of lateral attachments, is free to move either to the right or left of the median plane when the spine is inclined to either side."

Another theory offered in the explanation of the torsion or rotation accompanying scoliosis is that a flexible body bent in two planes at the same time, is accompanied by rotation. The vertebral column, if normal, has a series of antero-posterior curves. It is a homogeneous column, consequently side-bending would result in rotation since the flexible spinal column would be bent in two planes at the same time,viz., antero-posteriorly and laterally. This is true of all flexible bodies.

In the initial stages only the intervertebral cartilages are affected, but later on as the curvature progresses and develops, the vertebræ, the bodies in particular, become compressed on the concave side after which it is almost, if not entirely impossible to correct the deformity. The mobility of the spine is lessened; the **muscles** on the concave side undergo atrophy on account of pressure on their trophic nerves and from imperfect, or non-use. Those on the convex side increase in size and are made prominent, partly by increase in size and partly by change in contour of the thorax.

One of the earliest signs of a scoliosis is a hypertrophy of the muscles

Practical Surgery, Walsham. p, 581.

on the convex side of the spinal column, especially the erector spinæ mass. This appears before any palpable deformity of the vertebræ takes place, or at least before it can be recognized.

The hypertrophy of the muscles on the convex side is the result of the disturbance of the equilibrium of the body. Immediately after the

FIG. 108.—Showing a simple scoliosis to the right, from atrophy and non-use of the back muscles. The thoracic muscles were almost entirey paralyzed so that there was practically no movement of the chest on respiration. (From photo).

body has lost its poise, say for example, it is tilted to the right, the muscles on the left side are brought into activity to prevent gravity from drawing it further to that side. In the constant effort on the part of the muscles on the left side to prevent this, they necessarily undergo hypertrophy. This muscular enlargement and contracture is the result of the curve rather than the cause. Some believe that muscular contracture is an important cause of scoliosis but this is scarcely possible. Muscular relaxation is by far the more important of the muscular causes. The character of the rotation which accompanies practically all cases of scoliosis, contradicts the theory that muscular contracture or contraction produces the curve, since it is opposite in direction to that produced by the action of the muscles.

The **foramina** on the convex side are increased in size, those on the concave side lessened. The lessening in size of the foramina produces more or less pressure on everything that is in them. Pressure on the blood-vessels interferes with the nutrition of the spinal cord, column and other structures in relation, such as the spinal membranes and ligaments. This leads to muscular atrophy and visceral weakness. Pressure on the nerves results in (1), sensory disturbance, such as pain or weakness in the spine on movement, a careful gait, stooping posture and lack of inclination on part of the child to enter into play as do other children; and (2), motor and trophic disturbances, as are manifest in the atrophied muscles. Vaso-motor and secretory impulses may be interrupted, leading to secretory and vascular disturbances in areas supplied by these nerves. The recurrent meningeal nerves are compressed, this leading to vascular and trophic disturbances of spinal cord and column. These effects are the same as from lesions of individual vertebræ with the exception that they are more general.

The **scapula** on the convex side, if the curve is in the thoracic region as it is most commonly, is thrown upward and backward, giving it a winged appearance. The shoulder is also higher on that side. This change in the scapula is one of the very early signs and should be regarded as an important one. One side of the pelvis soon becomes prominent, that is the crest on the convex side. The **ribs** on both sides of the thorax are changed in position, giving a misshapen appearance to the chest. Posteriorly, the chest is prominent on the convex side and depressed on the concave side. Anteriorly, the side of the chest bulges on the side of the concavity of the curve and the opposite side is depressed. These

changes occur early and are important signs of a lateral spinal curvature. The deformity of the thorax is most marked when rotation is greatest, **since the ribs follow the transverse processes of the vertebræ with which they articulate.** In some cases the spinous processes may remain in the median line until the curvature is well under way, **hence**

Fig. 109.—Simple lateral curvature of the spine. P., prominence of the scapula and ribs. Compare the points marked with an X. There is some rotation as is indicated by the prominence on the right side. (From a photo).

scoliosis should not be diagnosed in every case by position of the spinous processes.

A scoliosis is primarily caused by an injury to a vertebral articulation or by any other cause producing faulty posture, which in turn pro-

duces unequal pressure on the discs. It produces disease by interfering with the functions of the spinal column, cord, nerves and nerve roots, muscles, vessels and viscera in relation or connected with the affected part. Most of these effects result from a lessening in size of the intervertebral foramina. All curvatures are not pathological since compensation may be complete. In cases in which compensation is not perfect, the curvature is pathological.

The condition known as a **straight spine**,is common in certain classes of people. It is primarily due to weakness of spinal ligaments and muscles and is found in malnourished, anemic, tubercular patients and those predisposed to lung diseases, particularly phthisis. It is caused by relaxation of the ligaments, cartilages and muscles that hold the spine in its normal position. In most cases a single vertebral lesion is found, usually at the fourth dorsal articulations, but sometimes slightly higher or lower in the spinal column. The effects are explained in the same way as those in anterior and posterior curvatures, with the exception that the trophic effects are more marked since the upper and middle thoracic regions are affected most.

The **rigid** and **hypermobile spines** have to do with changing the contour of the back. The **rigid spine** results from abnormal approximation of the vertebræ or impairment of the ligaments and muscles which support and move the spinal column. Old age, standing on the feet a great deal, inflammatory conditions of the spine, as in meningitis and la grippe, lesions, thickening of the spinal ligaments, and rigidity or inflammation of the spinal muscles all tend to lessen mobility. Fractures, sprains, subluxations and dislocations of vertebræ are also important causes. Long continued muscular contracture exerts such a pressure on the discs that they are abnormally, thinned and flattened. Such a condition interferes with the function of the spine and lessens the size of the intervertebral foramina. In constipation and fibroid tumors of the uterus, a rigid lumbar spine is nearly always found. In the aged, a rigid spine is not uncommon and is not usually regarded as pathological, yet in every case in which the intervertebral foramina are lessened in size, pathological conditions result. In many cases in which the spine is apparently mobile, there will be found **areas of several adjacent vertebræ, in which motion is decidedly lessened or entirely lost.** The movement of the vertebral articulations **should be distributed amongst all of them,** but this is not the case in many spines. At sòme place, usually at a

FIG. 110.—Showing a straight spine. (From photo). Note the spinous processes are visible throughout the entire spine.

break or separation, there is hypermobility, which compensates, so far as mobility is concerned, for the rigid, immovable area. As mentioned above, a rigid spine, or even one rigid immovable vertebral articulation, is abnormal and produces disorders of structures in relation and of viscera supplied by the nerves passing through the obstructed foramina in relation.

Hypermobility is the result of relaxation of the supports of the spinal column, viz., the ligaments and muscles. It occurs most frequently in improperly nourished young girls. This weakness may be the result of lesions disturbing the centers for nutrition or it may be the result of some visceral disturbance especially derangement of the sexual organs. In all cases of general hypermobility of the spine, the dorsal curve is lessened, often entirely obliterated, and the lumbar spine is posterior. The spines of the vertebræ appear to be larger than those of normal vertebræ; the patient tires easily on the slightest exertion, cannot or does not sit erect and suffers with various spinal aches which are increased in intensity with extra work or strain. This condition produces disorders by interfering with the function of the spinal column, spinal cord, nerves, muscles and viscera. The spinal column is weak, the spinal cord poorly nourished, the spinal membranes often congested and inflamed, the nerves irritable and the viscera weak, so that almost any exciting cause will produce marked disorders.

Enlargement of the lungs, liver, distension of the stomach, tumors, aneurysm and abscesses sometimes change the contour of the back. Displacement of the ribs, paralysis of the serratus magnus muscle and contracture of muscles from the various causes, also change the contour of the back.

Congenital defects, such as **spina bifida,** produce abnormality in contour of the spine. **Spina bifida** is a condition in which there is absence of a portion of the lamina, causing imperfect closure of the spinal canal at that point. As a result the pressure from within causes a protrusion of the membranes of the cord, which is characterized by a soft, fluctuating tumor varying in size with that of the opening. The tumor or sac is filled with the cerebro-spinal fluid that normally surrounds the spinal cord. This condition may seriously impair the function of the spinal cord at and below the seat of the tumor. Paraplegia is a common sequel.

In some cases there is an abnormal development of a spinous process which is mistaken for a lesion. There are other causes and forms of

irregularities, such as large, uneven spines and breaks or separations that are often due to changes confined to the spinous processes; that is, it is an apparent, not a real, lesion since the articular processes are not involved. In chronic cases of diabetes mellitus the spinous processes of the lower dorsal and upper lumbar vertebræ are enlarged and prominent. Often there will be found lateral deviations that are simply irregularities due to a bending of the spinous process. Changes in contour of the upper dorsal spine, indicate weakness of lungs; middle dorsal, weakness of stomach and liver; lower dorsal, weakness of kidneys; lumbar region, weakness or disease of the lower intestinal tract and pelvic organs. These changes of contour, if pathological, are accompanied by either tenderness, muscular relaxation or by weakness of viscera innervated by that part of the spinal cord in relation.

Tenderness and **aching** of the spine are very common symptoms. When in the upper thoracic region, they are suggestive of colds, la grippe and lesions of the vertebræ or ribs. In the interscapular region, they are suggestive of lung and heart disease, occupation neuroses and pelvic and mammary disorders; in the middle and lower portions of the thoracic spine, they are indicative of stomach and liver disorders; lower dorsal and upper lumbar, disorders of kidneys, spleen and small intestines; in the lumbar region, they are almost diagnostic of disorders of the bowel and pelvic generative organs. In all of these areas the tenderness or ache may be due to a subluxation of a vertebra or rib, in fact tenderness of a vertebral spine is one of the most certain indications of a lesion of that vertebral articulation. Tenderness of the spine may be due to reflex irritation of the sensory nerves supplying the spinal column; that is, if there is an irritative disease of a viscus the segment of the spinal cord that supplies the viscus, will be affected, which in turn causes the pain to be referred to the spine. Similarly, the muscles supplied by the affected segment undergo contracture, hence contracture of spinal muscles is indicative of an irritative disorder of viscera in relation.

If there is excessive tenderness along the spine, it is suggestive of spinal irritation or neurasthenia. In many cases there is ovarian irritation. In all cases there is a congested condition of the nerves of the back and disturbances of the spinal cord and its membranes. In other cases, the toxemia is the cause of the irritation of the sensory nerves of the back, this giving rise to the extreme tenderness on account of the malnutrition. An error in diet will produce both tenderness at or near

Fig.111.—Lateral view of the spinal column. Note the relation of spinous processes, foramina, bodies and nerves

the fifth dorsal spine, and contracture of muscles in this region. In railway spine, in which there is concussion of the spinal cord, the effects vary with the degree of disturbance of the cord. In some cases there is a dislocation, in others a subluxation, or a fracture or crushing of the vertebræ. In the so-called railway spine, I believe the trouble in the average case, is due to a vertebral subluxation which produces the pain or anesthesia or the paralysis. The symptoms in railway spine are often anomalous from the usual viewpoint, but from the standpoint of subluxations of the vertebræ, most of the symptoms are explainable.

Fracture of the spine is rare and is the result of severe trauma. If it occurs above the fourth cervical vertebra, death is the result, but if at points below, paraplegia is the sequel. Death may result from fractures at these points on account of hypostatic congestion of the lungs or other viscera, interference with nutrition and elimination or, from exhaustion. The effects are determined by the location and degree of the fracture. It is hard in many cases to differentiate between fracture and dislocation or subluxation. Careful palpation, by which crepitus can be discovered if it is a case of fracture; the severity of the paralysis or effects on the spinal cord, they usually being very marked in cases of fracture; and the use of the X-ray, especially if the lumbar region is the seat of the injury, will reveal the nature of the injury.

THE SPINAL CORD.

The vertebral column is tunneled by a **foramen** in which the spinal cord is located. The cord is much shorter than the spinal canal, reaching only to the upper border of the second lumbar vertebra in the adult and in an infant, to the third lumbar vertebra. It is about eighteen inches long and varies in its diameter, being smallest at points of greatest mobility. It is surrounded and protected by the meninges and the cerebro-spinal fluid. The cord is well protected, a thing that is essentially necessary on account of its delicacy and function. Deaver says in regard to its protection: "The free mobility of the spinal column as a whole; the slight amount of movement between any two vertebræ; the elastic intervertebral discs which break up force and shock applied to the spinal column; the comparatively large size of the spinal canal in the cervical and lumbar regions where the mobility is most marked; the curves of the spinal column which lessen shock and force; suspension of the cord in the spinal canal by the ligamenta denticulata; the spinal dura

FIG. 112.—Lateral view of the spinal cord.

mater which is so tough that the cord may be ruptured without laceration of the dura; and the cerebro-spinal fluid." Although the cord is surrounded by these safeguards, it is often affected in many ways, as stated below.

The cord is composed of white and grey matter. The **white matter** contains the nerve fibers cemented together by the neuroglia. These nerve filaments are divided, on account of function and relation, into columns, the anterior and lateral being motor, the posterior, sensory. Dana says, "On physiological and embryological grounds the columns are further subdivided as follows: The anterior columns are divided into direct pyramidal tract and anterior fundamental column. The lateral columns are divided into lateral fundamental columns, lateral limiting layers, crossed pyramidal tracts, direct cerebellar tracts and antero-lateral ascending and descending tracts, or Gower's column. The posterior columns are divided into the posterior internal column or column of Goll, postero-external columns, or column of Burdach, the ventral zone, the comma, the oval zone, the triangular column and rim zone or column of Lissauer."

The **grey matter** occupies the center of the cord and its parts are arranged like the letter H. It is composed principally of nerve cells with some nerve fibers and neuroglia. Each lateral half presents two horns, the anterior and posterior, the two halves being connected by a commissure. The nerve cells are arranged in groups. Dana says: "The cells are surrounded by a rich plexus and end brushes, as well as by the supporting neuroglia matrix, a little connective tissue and many small blood-vessels. The cell groups are named in accordance with their position, internal, antero-lateral, median, posterior or sensory cells, cells of Clark's column." The **blood supply** of the cord, and especially of the grey matter, is of great importance since many diseases of the cord are the direct result of conditions that affect it. It is supplied with blood from the vertebral, ascending cervical, superior intercostal, dorsal intercostal, lumbar and sacral arteries. The vertebral artery gives off the anterior, posterior and lateral spinal. The anterior, according to Church "gives off about three hundred branches called the anterior median arteries which penetrate the anterior fissure at a right angle to the parent stem. At the commissure they enter the cord and, without dividing, turn toward the right or left anterior horn." The white matter in the anterior portion of the cord is also supplied by

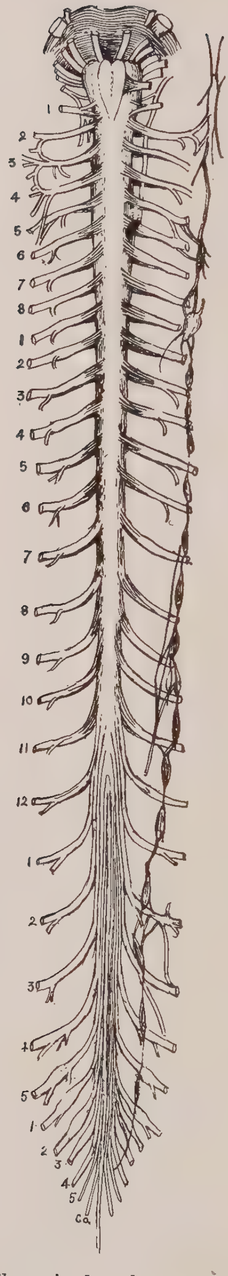

FIG. 113.—The spinal and gangliated cords.

branches from this artery. This artery is reinforced by the lateral spinal branches. The posterior spinal arteries enter into an anastomosis with the lateral spinal, thus forming a plexus extending along the entire cord. Twigs are given off which supply in particular the posterior horns of the grey matter. They are regarded by most observers as "of the terminal variety and therefore do not anastomose." According to Church there are three arterial districts: (1), "That only supplied by the anterior system; (2), that supplied only by the posterior system; and (3) that irrigated by both systems. It will be apparent from these facts that arterial disease may induce lesions in the posterior half of the cord, or in the anterior half. Further, the infection or obliteration of a single anterior median artery will practically destroy the corresponding horn." The **lateral spinal** branches pass through the corresponding foramina with the nerves and in its sheaths of dura mater, and supply in particular the corresponding segment of the spinal cord. The lateral spinal, for the upper part of the spinal cord, come from the subclavian, while the lower part is supplied with blood by the thoracic and abdominal aorta. Dana says: "It is an interesting fact that at or a little below the point where the blood supply changes from the subclavian above the heart to the aorta, below, pathological disturbances frequently occur (transverse myelitis)." On account of the length of the anterior and posterior spinal arteries they are not subject, according to Church, to the direct impact of the cardiac impulses. "Arterial pressure is also slight, and the venous outlet into the plexuses about the dura mater is not an advantageous one in the erect position." The lateral spinal branches come from the dorsal branches in the different regions. This artery sends a branch into the cord, the lateral spinal, and continues as the muscular artery to the muscles of the back. In contractured conditions of muscles as we ordinarily find them, the muscles are congested. In such cases, **the circulation through the muscular branch is practically obstructed, the blood backs up into the lateral spinal branch and the spinal cord becomes congested.** The conclusion from this is that **contractured muscles of the back produce congestion of the spinal cord**, and that any treatment which lessens the contracture of these muscles, will better the circulation through the spinal cord.

The **veins** correspond in their distribution to the arteries. The blood from the cord substance is gathered into the anterior and posterior system of veins, which empty into the lateral spinal except at the ex-

treme upper part of the cord, at which place some of the blood passes into the sinuses of the brain. Most of the venous blood is gathered by the venæ azygi. These veins are subject to pressure, on account of their position, from enlargement or congestion of viscera in relation or from long continued pressure, as in a lingering illness in which the patient assumes the dorsal posture without much change. Contractured muscles have an effect on the veins similar to that on the arteries, that is the spinal cord becomes congested in such cases.

The spinal cord has the following **functions**: (1) **conductivity,** conveying motor impulses from, sensory impulses to the brain; (2) **centers** that control the activities of viscera and the size of the blood-vessels; (3) centers for **reflex** action; and (4) control of **nutrition** of parts to which its nerves extend. In short, its functions may be classified as (1) a **conductor of impulses,** and (2) a **series of nerve centers.** These functions of the spinal cord may be disturbed by many things.

Lessened mobility of the spine weakens nature's protection of the spinal cord against injuries. The various shocks are less completely broken, the discs are less elastic, the ligaments are more tightly drawn, and the spinal column usually impacted, thus lessening the size of the intervertebral foramina. Lessened mobility of the spine produces a vascular change in the cord, since the **contractions of the spinal muscles** are of great value in the circulation of the blood through the spinal cord, and these contractions have almost, if not completely, disappeared in stiff spines. This is explained by the relation of the muscular, to the spinal branch of the artery that supplies both. Instead of the normal contractions, are found muscular contractures which interfere with the circulation to the cord. If the lessening of mobility is localized in one or two intervertebral joints, the effects are not so marked but the function of that part of the spine is suspended. Lessened mobility of the spine then affects the spinal cord principally through the effects on its circulation, this coming about through a lessening of the size of the intervertebral foramina, lack of normal contractions of the spinal muscles in relation, and the presence of muscular contractures in these same muscles. This condition also lessens the elasticity of the spine, hence the spinal cord is not so well protected against jars of the body or injuries. A stiff spine is more easily injured than one in which the motion is good, other things being equal, and when fracture, dislocation or subluxation of a vertebra occurs, the spinal cord is always affected.

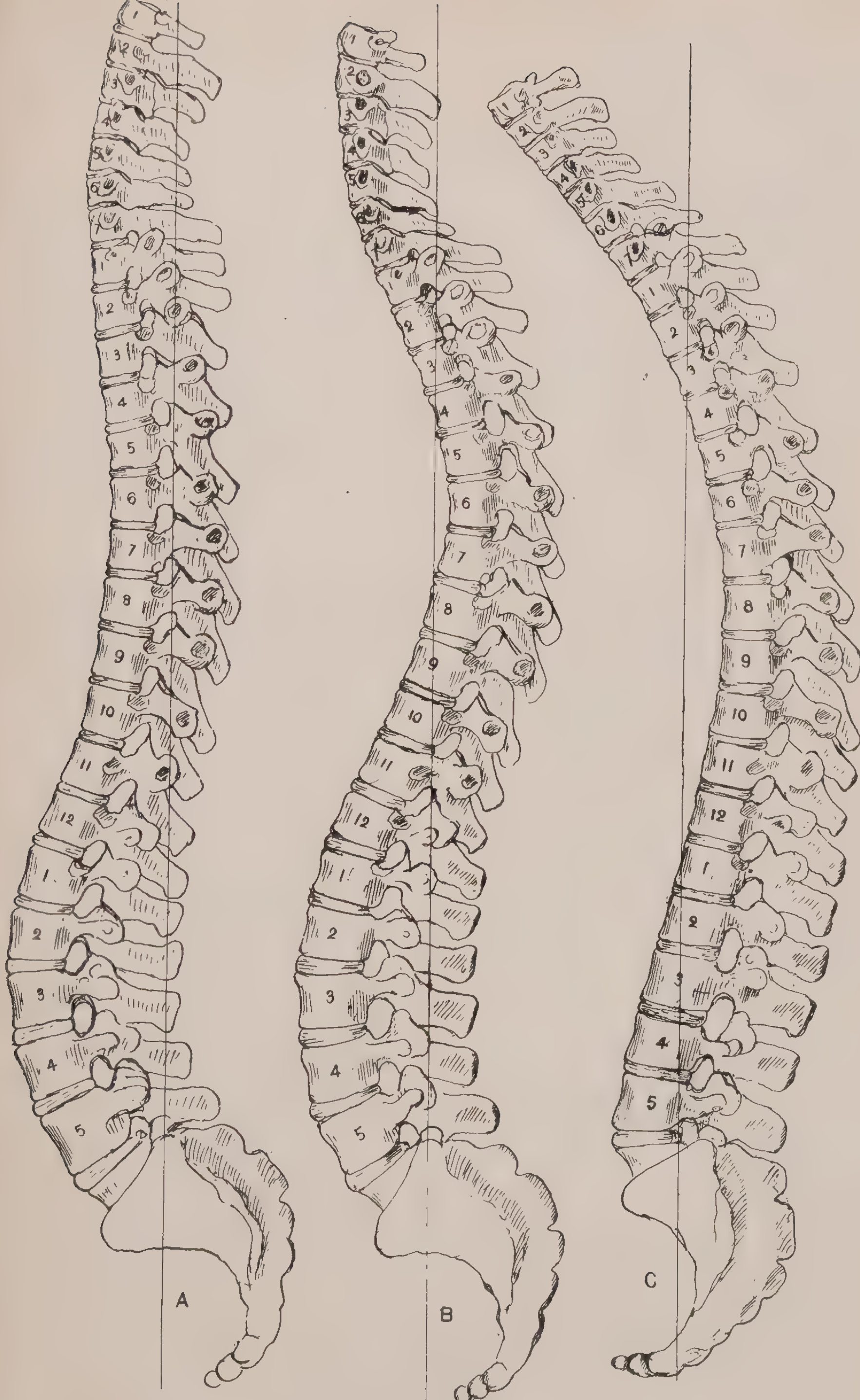

FIG. 114.—Showing changes in contour of the spine. B., normal spine; A., Flattening of the thoracic region; C., posterior in lower thoracic and upper lumbar regions. Note the effects on the size of the intervertebral foramina. Compare position of the coccyx, angle of sacrum and line of gravity.

The **intervertebral discs** assist in the protection of the spinal cord in that they lessen the jar on the cord from running, etc., and permit of free movement of the spinal column. If their elasticity is lessened, if they are thinned, or if one side is malnourished, they the less securely protect the spinal cord since the spinal cord is more easily disturbed, as in concussion; the foramina are lessened, hence impairment of nutrition from which spinal curvature develops.

A **change in the normal curves** of the spinal column, as in straight spine or any curvature, will more or less affect the spinal cord, depending on the character, rapidity, and degree of the change. The normal curve lessens, to the greatest extent, the effects of shock and force. A change in the curve of the spine thus makes the cord more susceptible to shock and concussion. In addition, the circulation and nutrition are affected on account of the change in size of the intervertebral foramina; thus producing pressure on blood-vessels and nerves. The functions of the cord are impaired then, from the interference with the passing of nerve impulses and of blood, to and from the cord.

The **cerebro-spinal fluid** commutes the force of a shock and thus prevents injury to the cord. This fluid may be pathologically lessened or increased in amount, which conditions predispose to injury of the cord.

Lesions of the articulations of the **vertebræ and ribs** are responsible for most disturbances of function of the spinal cord. As in some of the conditions described above, I believe most of these effects come from a partial or complete closure of the intervertebral foramina. If a vertebra be subluxated in any way, either the foramen above or below it, is lessened in size, the amount of change depending on the degree or extent of the lesion. The artery supplying the cord with nutrition is thus partly or completely ligated. The same is true of the veins and lymphatic vessels. Circulatory disturbances of any character may then follow the lesion. Congestion, especially venous, is the most common since the vein is affected more in proportion than is the artery. Contracture of muscles of the back will have a similar effect. The nerves passing through the foramen, the recurrent meningeal and the common trunk of the spinal nerve, are also compressed. The recurrent, carries trophic and vasomotor impulses to the cord and its membranes. The effect is that of congestion or anemia with its consequent disturbance of function. The common trunk carries afferent impulses to and efferent impulses from the spinal cord. The cord may suffer especially from the effects on the

afferent roots. This disturbance of the afferent roots often comes from a spinal lesion, that is from subluxation of a vertebra. The pressure on the efferent nerve fibers produces muscular and visceral disorders, which in turn, disturb the circulation of the spinal cord, affecting its functions. If the lesion be irritative, it will produce a thickening and increased vascularity of the ligaments, a stimulation of the nerves, contracture of muscles and disturbance of the meninges, this being in the form of a congestion or inflammation. Hyperesthesia of the spine is a sequel to the last named condition.

The functions of the spinal cord may be affected by **pressure,** as in complete dislocation or fracture of a vertebra, and in tumors, whether vascular or otherwise. The effects vary with the degree of pressure, paraplegia, however, being the most common effect. The pressure is not only on the blood-vessels and nerve roots, but is directly on the cord itself and results in interference with both conductivity and the generating of nerve impulses. Transverse myelitis occurs in cases of fracture and complete dislocation.

The condition of the spinal column is a good index to the condition of the spinal cord, or conversely, disturbance of function of the spinal cord is manifest by changes in the spinal column. A rigid spine, in which the rigidity is due to muscular contracture, is suggestive of disease of the anterior or lateral columns, as in spastic paraplegia. General relaxation or paralysis of the spinal muscles indicates a chronic transverse myelitis. A tender spine is suggestive of a congested cord or inflamed or congested spinal membranes. Atrophy of a localized portion of the erector spinæ mass of muscles, in indicative of inactivity of the trophic and motor cells in the corresponding segments.

Abuse of function of certain viscera, especially the **gastro-intestinal** and **genital tracts,** will affect the functions of the spinal cord. It is a general law that activity produces congestion or hyperemia. If the fingers are vigorously opened and closed, hyperemia follows. If the brain is used, a greater amount of blood flows to it. If the stomach is stimulated from the ingestion of food, it becomes congested and in addition the nerve centers in the spinal cord become congested. If sexual intercourse is indulged in, not only the parts directly concerned become hyperemic, but the spinal cord—that part giving rise to the nerves that take part in the process—also becomes hyperemic. In abuse of function of the viscera the congestion in the spinal cord becomes pathological.

Paraplegia from hemorrhage in the cord has resulted from vigorous coitus. Contracture of the spinal muscles follows a short while after the ingestion of something indigestible. Overactivity leads to pathological congestion. In cases of insanity due to worry, I believe that a localized part of the brain is overworked, is constantly used to the exclusion of other parts, consequently, after a while the congestion becomes a pathological one. The treatment is rest, diversion of the mind, or anything to equalize the cerebral circulation. Thus it is with the spinal cord, sexual abuses repeatedly produce congestion of the genital centers until finally they become pathologically congested and thus the cord is affected as to function.

The functions of the cord are often disturbed by a **toxemia.** This may come from tetanus, syphilis, or in fact from any form of toxic material that may be in the blood. This toxemia produces at first a congestion, but later on in chronic cases, an inflammation. The disturbance of function varies with the kind and intensity of the poisonous material, opisthotonous occurring in acute cases, sclerosis in chronic cases.

The **effects** of disturbance of function of the spinal cord, vary with the part affected and the way it is affected. If the white matter is disturbed, conductivity is impaired. The motor columns may alone become diseased as in spastic paraplegia, or the sensory columns may be affected as in tabes dorsalis. If the motor columns are affected by the lesion, the brain can no longer exert an inhibitory influence on the various muscles and nerve centers, and the reflexes are exaggerated. The various centers often act independently of the higher centers as is demonstrated by the involuntary evacuation of urine and feces. If the part of the cord below these centers is involved, there will be retention or dribbling of urine. In other cases of transverse myelitis, motion and sensation are lost in parts below the lesion, since motor impulses arise in the brain and the sensorium is the receiver of all sensory impulses. If conductivity is only disabled or partly lost, there will be a partial connection between the brain and parts below the lesion. Painful impressions are supposed to be carried by the grey matter; sensations of touch by the lateral columns and the grey matter. Both of these columns are in the side of the cord opposite to that of the stimulus; that is, if the left side of the cord were affected, the effects would be on the right side of the body.

The **vaso-motor centers** in the cord are usually affected by lesions

of the vertebral articulations and by disease of the cord. Gowers says: "The sympathetic nerves to the vessels are influenced from the spinal cord. It is probable that the path is by the fine fibers of the anterior roots and that most of the constrictor fibers leave the cord between the third dorsal and second lumbar, while the dilator fibers are more widely scattered, many arising in the upper dorsal region, while others leave the cord in its lumbar and sacral portions (pelvic outflow). Some facts of disease suggest that the subsidiary vaso-motor centers are situated in the intermediate grey matter; and this conclusion is supported by the important researches of Gaskell, which refer the function to the small cells of the intermedio-lateral tract which he traces upward to the vaso-motor center in the medulla." The effect on the cord of a lesion or other disturbance may be that of stimulation or inhibition. If the former, contraction at least for a while, of the blood-vessels governed by that part will take place, while if the vaso-motor centers are inhibited, dilatation of the vessels will result. Thus congestion or anemia may result from these vaso-motor disturbances. The head and face have their vaso-motor centers in the lower cervical and upper dorsal portions of the spinal cord. If the lesion inhibits these centers, congestion of the above parts takes place; if the lesion is irritative, anemia is the result. Congestive headaches, congestion of the eyes or any part of the head and face, can often be cured by correcting a lesion of an upper dorsal vertebra. I believe that every muscle fiber of every artery and vein in the body is represented in the spinal cord by a cell which nourishes it and controls its action. These cells are grouped and constitute the vaso-motor centers. The cell must be properly nourished and the line of communication between it and its muscle fiber must be clear, if it is to act normally. If the impulses are interrupted or if the cell is inactive, the muscle fiber is not properly nourished and becomes relaxed. If the cell or its nerve filament is stimulated, contraction of the muscle fiber results.

The **sensory** effects are manifest on the opposite side of the body; that is, a lesion of the left side of the cord would be manifest by sensory disturbances on the right side of the body. Girdle pains, as in locomotor ataxia; numbness or anesthesia, as in atonic paraplegia from transverse myelitis; perverted sensation, as in syringomyelia; and disturbances of tactile sensations and of heat and cold are the principal sensory effects of lesions or diseases that disturb the sensory columns of the spinal cord.

The **motor effects** of disturbance of the functions of the spinal cord are paralysis, with atrophy or with spasticity, which are represented by simple paraplegia and spastic paraplegia. The motor impulses may be entirely cut off, partly inhibited or stimulated by the disturbance in the spinal cord. The muscular fibers in the various viscera are more or less under the control of the spinal cord. Gowers says: "Although the viscera are under the immediate control of the sympathetic system of nerves, they are related to centers in the spinal cord, and it is from these centers that the controlling influence is really derived, probably by means of the finer fibers of the anterior roots. The relation is the most direct and important so far as concerns the disease of the spinal cord, in the case of the organs over which the will has an influence, the rectum and the bladder." The visceral effects of a disturbance of the spinal cord would therefore, be increased or lessened peristalsis, that is increased or decreased activity above or below the normal. Diarrhea is an example of the former, constipation of the latter. In chronic spinal cord diseases, the sympathetic gangliated cord attempts to take on the function of the spinal cord, sometimes successfully, as is illustrated in cases of transverse myelitis in which the sympathetic cord controls nutrition, circulation and, to a certain extent, the various reflex processes.

The sexual function is always disturbed in spinal cord disease. This disturbance ranges from complete impotence to priapism. This applies especially to diseases that involve the lumbar enlargement of the cord.

The **trophic effects** of spinal cord disease are sometimes wonderfully rapid and extensive. The trophic cells are in the anterior horns of the grey matter of the spinal cord. Every part of the body receiving impulses from the spinal cord would be affected by any disease of the cord involving these centers. This trophic influence is exerted principally through the motor nerves. It involves muscles, ligaments, bones, skin and viscera. The tone of muscles depends on activity of the center. The effects of impairment of this function of the spinal cord would be malnutrition, relaxation, caries and the formation of bed sores or necrosed areas, if the disturbance is acute or destructive, as in some cases of myelitis.

The spinal cord is a very important part of the cerebro-spinal axis. It not only transmits impulses to and from the brain, but originates

many impulses. Its activity or function depends on the condition and amount of blood circulating through it. Lesions of the vertebræ affect both and give rise to disturbance of function. **Many of the results** obtained by osteopathic treatment come from **restoring normal circulation to and from the spinal cord.** To do this, correct all anatomical derangements, such as subluxated vertebræ and contractured muscles, that lessen the size of the intervertebral foramina or produce in any way, congestion of the muscles or cord.

THE RIBS.

The **ribs,** together with the sternum, form the thorax on the sides and front, the bodies of the thoracic vertebræ forming the posterior wall. They are flattened, twisted, hoop-like bones which articulate with the bodies and transverse processes of the thoracic vertebræ and are so arranged that their length and obliquity increase from above downward, the former to the false ribs, the latter to the tenth. This obliquity is so great that the sternal end of the rib is several vertebræ lower than the vertebral end of the same rib. They are divided into true, false and floating, which number seven, three and two, respectively.

A **typical rib** consists of a head, neck, tubercle, angle and shaft. The **head** is divided into two parts by a ridge which gives attachment to a ligament, the inter-articular. The **facets** are slightly concave, the lower usually being slightly the larger and articulates with the upper part of the body of the vertebra in numerical correspondence. The upper articulates with a facet on the lower part of the vertebra above. The movement at these facets is slight, being a sort of rotation. The **neck** is the constricted portion between the head and tubercle. It is smooth anteriorly but its posterior surface is rough for attachment of ligaments and muscles. The **tubercle** consists of an enlargement which has two parts, an articular and a non-articular. The articular part is slightly convex, of oval shape, faces downward, backward and slightly inward and articulates with the facet on the transverse process of the corresponding vertebra. The movement at this articulation is a slight up and down one with some rotation. The non-articular part gives attachment to the costo-transverse ligament. The angle of the rib corresponds to the point of greatest curve, there being a rough ridge which runs obliquely across the shaft. It is the part that can be best palpated in up-

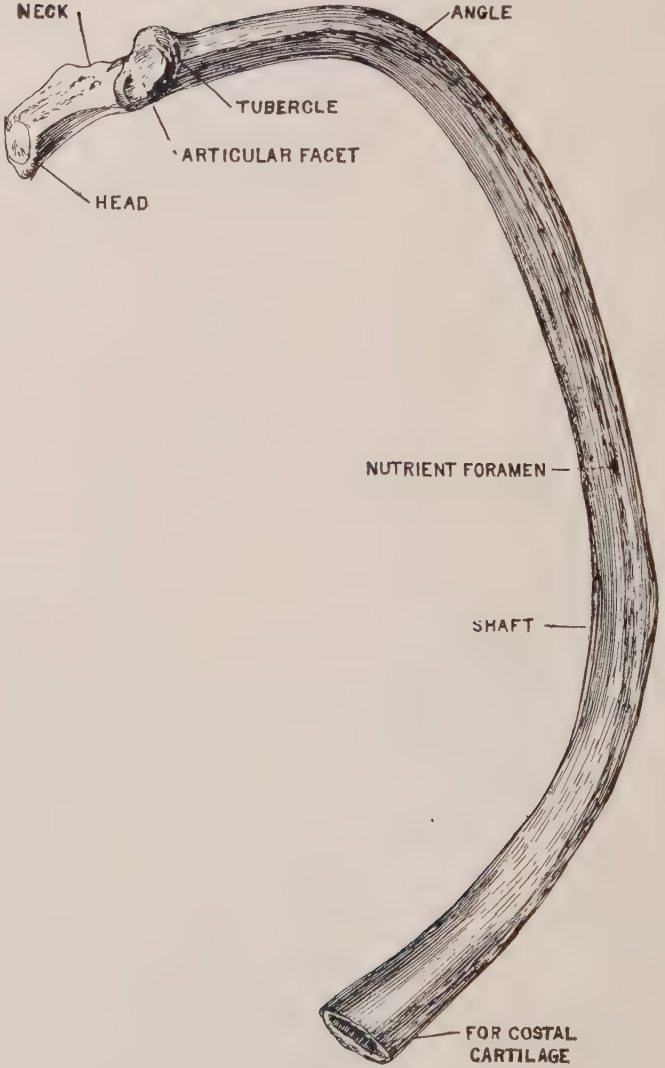

Fig. 115.—A typical rib.

ward subluxations of the rib, in which case the angle appears at a prominence which is usually quite tender. The prominence is due partly to thickening of the tissues and partly to the displacement upward. Beyond the tuberosity, each rib is prolonged as a twisted, flattened, thin hoop, which part is called the **shaft.** It presents an upper border which is rounded and smooth and considerably thicker than the lower border. This gives attachment to the internal intercostal muscles and a few fibers of the external intercostals. In upward subluxations of the rib, this border can be quite clearly outlined.

In enlarged chests, as in asthmatic patients, the ribs are drawn upward and forward, thus bringing into prominence the upper border of the rib. The lower border or edge is quite thin. It is grooved for the passage of the intercostal nerve and vessels, the outer edge of the groove being quite sharp. It gives attachment to the external muscle, while the inner edge gives attachment to the internal intercostal muscle. Near the anterior end of the rib, the groove disappears and its lips or sides unite to form a rounded edge. The openings in the rib for the passing of blood-vessels are in the floor of the groove. They are called nutrient foramina. This border of the rib can with difficulty be palpated in a full chested subject, but in patients suffering with pulmonary tuberculosis, or from emaciation from any cause, it can be readily outlined. In such cases the ribs are in a position of descent, and the lower the sternal end, the shorter the antero-posterior diameter and the more prominent the lower edge. In downward displacement of the anterior end of the rib, the lower edge can be plainly outlined. This furnishes a reliable sign in the diagnosis of a rib lesion. In collapse of the lungs the lower edges almost, if not actually, overlap, as does the weather-boarding of a house.

The **external surface** is smooth and convex, thus conforming to the general curve of the thoracic wall; that is, the first rib faces upward; the upper ribs, upward and outward; the middle, outward; and the lower ribs outward and slightly downward. Some muscles are attached to this surface, such as the pectoralis major and serrati muscles. The inner surfaces face opposite to the external and give attachment to the parietal layer of the pleura. As each rib approaches the sternal end it becomes twisted on its axis in addition to the curve. This gives it a spiral shape which can best be appreciated by placing the rib on a plane surface, it being found that the two ends can not be kept down at the

same time. The curve and twist are most pronounced at the angle of the rib. Many a person owes his life to the obliquity and curvature of the rib, since they the better deflect the course of a pistol ball, which follows the rib instead of directly entering the thoracic cavity. The anterior end of the rib is larger, more porous and has a cup shaped depression for articulation with the costal cartilage.

A typical rib has three **articulations,** two with the vertebra and one with the costal cartilage. The articulation of the head of the rib with the bodies of the vertebræ is a diarthrodial one and is classed as a hinge-or ginglymoid joint on account of the character of its movement. The head has two facets, the upper one articulating with the vertebra above, the lower one with the vertebra below and the center of the head articulates with, or rather is attached to, the intervertebral discs by means of the interarticular cartilage. On account of this arrangement, subluxation of a vertebra will quite readily affect the head of the rib.

The **ligaments** of the costo-vertebral articulations are the capsular, stellate or costo-vertebral, and the inter-articular. There are also two membranes corresponding to the two articular facets of the head and separated by the interarticular cartilage. Perhaps they have something to do with the "popping" sound which is often heard on movement of the head of the rib. The **capsular** ligament entirely encloses the articulation and is attached to the contiguous vertebræ, intervertebral disc and rib a little beyond the articular margins. The **stellate** seems to be a thickened portion of the anterior part of the capsular and consists of three glistening bands which pass upward, forward and downward from the head of the rib to be attached to, or inserted in the bodies and disc of the adjacent vertebræ, the upper fasciculus going to the lower part of the vertebra above, the middle to the disc and the lower to the upper border of the vertebra in numerical correspondence. These fasciculi are in relation with, and to a certain extent reinforced by, the anterior common ligament of the vertebral column.

The **interarticular,** attaches the ridge on the head of the rib to the intervertebral disc in relation, thus dividing the joint into two separate compartments. It does not hold the head of the rib tightly against the vertebra, but permits of a moderate amount of motion, as in rotation of the rib in respiration. In subluxations of the rib, this ligament is injured which often results in a deposit, this thickening it and interfering with the movement of the head of the rib. These costo-vertebral

articulations are innervated by filaments from the anterior divisions of the thoracic nerves in relation.

Each typical rib articulates with the tip of the transverse process of its corresponding vertebra. This articular facet, in the case of the upper five thoracic vertebræ, faces forward and slightly upward, thus giving support to the parts above, while the facets on the transverse

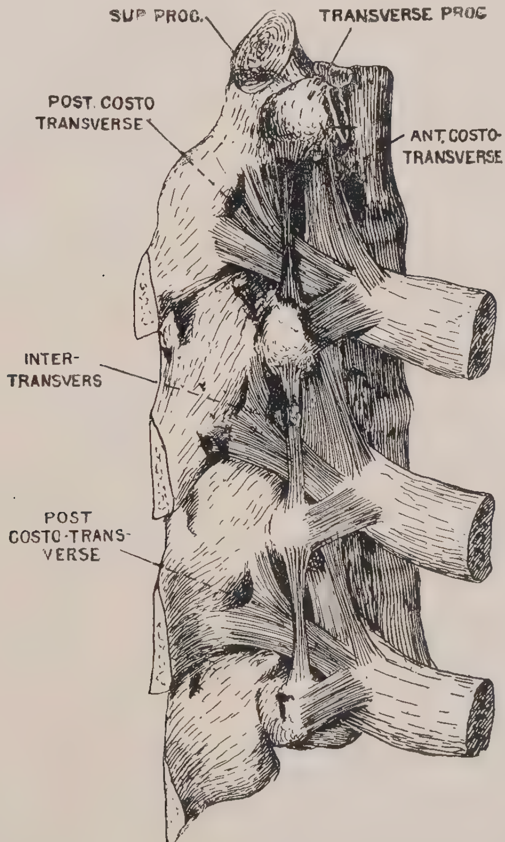

Fig. 116.—Costo-vertebral articulations viewed from the right side.

processes of the remaining thoracic, face forward and slightly downward. There are two ligaments uniting the tubercle of the rib to the transverse process, the capsular and costo-transverse, the latter being subdivided

into the anterior or superior, posterior and middle costo-transverse.

The **capsular** is a loose, thin envelope that surrounds the articulation, enclosing a synovial membrane. The superior or **anterior costo-transverse** ligament, consists of fairly strong bands which pass upward from the upper border or crest of the neck to be attached to the transverse process of the vertebra immediately above. The inner border helps to form the foramen through which pass the posterior branches of the intercostal nerves and vessels. In cases of subluxations of the rib in which this ligament is injured or impaired in any way, the size of this foramen would be lessened, hence there would be pressure on the nerves and vessels passing through. This applies especially to the veins and nerves. Pain or tenderness at the tuberosity of the rib or congestion of the integument, in relation often results from pressure on the sensory nerves and veins. The **posterior costo-transverse** ligament runs transversely and attaches the non-articular part of the tuberosity of the rib to the top of the transverse process. The **middle costo-transverse**, consists of short fibers that connect the posterior aspect of the rib with the front of the transverse process. It is always affected in an ordinary lesion or subluxation of the rib. The innervation is the same as that of the costo-vertebral articulations, viz., filaments from the intercostals in relation.

The **movement** of a typical rib is essentially one of rotation upward and outward on its axis which is directed obliquely forward and inward, passing through the costo-transverse and costo-vertebral articulations. In inspiration, the rib rotates upward on its articulations, thus drawing the anterior end upward and forward as it tends to assume the horizontal position. Perhaps, in addition to the rotary movement at the costo-transverse articulation, there is also a gliding one, the rib moving directly upward, especially in case of the lower ribs.

THE FIRST RIB.

The **first rib** is distinctly peculiar on account of its size, form, it being almost flat, and its degree of curvature. The **head** is small and has only one facet for articulation with the side of the body of the first thoracic vertebra. The **neck** is slender, longer and more nearly round than that of other ribs. It is slightly flattened from above downward, is smooth anteriorly and rough posteriorly for attachment of ligaments. The angle is exaggerated by the tubercle which is quite large. The

facet on the tubercle is small and articulates with a corresponding one on the transverse process of the first dorsal vertebra. This facet on the transverse process of the vertebra, is concave and faces slightly upward. On this account the weight from above is the better supported and in displacements of the first rib, it determines to a great extent the direction of the deviation, that is, it is most easily displaced upward. The **shaft** lies practically in one plane,so that if the rib is placed on a plane surface, it lies almost flat. Its **superior surface** looks forward and upward and has a tubercle for the attachment of the scalenus anticus muscle, and a groove immediately behind the tubercle for the artery, also a groove in

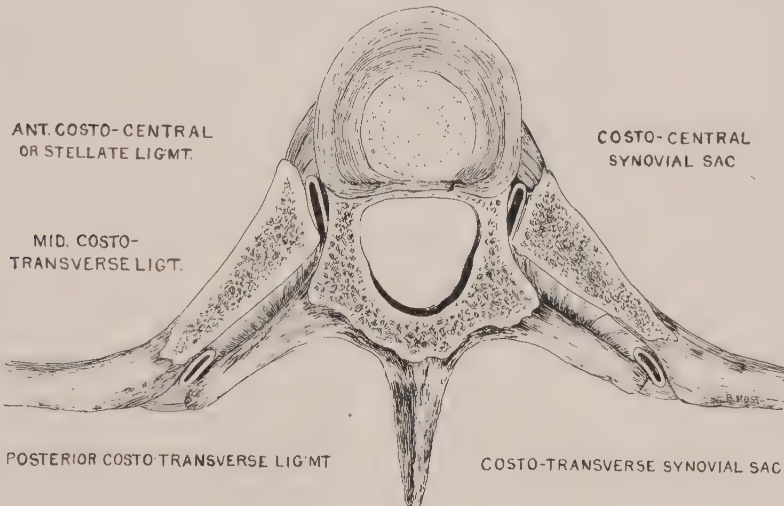

FIG. 117.—The costo-vertebral articulations viewed from above.

front for the subclavion vein, thus the muscle separates the artery and vein. To this surface are attached from before backward, the following muscles: subclavius, scalenus anticus, serratus magnus, scalenus medius, levator costæ and accessorius. These muscles on contracting, either fix or draw upward the rib. If they are in a state of contracture, they displace the rib upward. On account of attachment of most of the muscles posterior to the middle of the rib, the posterior end of the rib would be moved most on contracture of the muscles attached to the upper surface. The lower surface, smooth and flat, acts as a subcostal

groove and gives attachment to the external intercostal muscle; the inner edge thin, sharp and markedly concave, gives attachment to fascia.

The **movements** of this rib are slight, consisting of a slight up and down or gliding movement with some rotation. As in any rib, if it were not curved, the movement at the transverse process would be greater than at the head, but the twist in the rib permits of elevation of the anterior end with rotation at the costo-transverse articulation. This will apply better to the ribs that have a marked twist than to the first rib.

The **landmarks** used for locating this rib are for the sternal end, the sterno-clavicular articulation; the rib being immediately below and back of it; for the vertebral end, the vertebra prominens and transverse process of the seventh cervical, the angle of the rib being at the point of intersection of a horizontal line passing through the spine of, and a vertical line passed through the tip of the transverse process of, the seventh cervical. The angle and posterior part of the shaft can be palpated at the anterior border of the trapezius.

The vessels in relation are the subclavian artery and vein, which cross its upper surface, and the superior intercostal artery and vein, which cross the head of the first rib. The superior intercostal artery supplies the muscles in relation, the rib and a part of the spinal column and cord, the spinal branch entering through the intervertebral foramen with the eighth cervical nerve. The corresponding veins drain the muscles and spinal cord in relation. The subclavian vessels at this point carry the blood to and from the arm. Some lymphatic vessels are in relation, principally those draining the mammary gland, axilla and arm.

The **nerves** in relation with the first rib are the first intercostal, nearly all the nerves going to make up the brachial plexus, the recurrent meningeal and the stellate ganglion with its branches and communications. In addition to the above, the inferior cervical ganglion would be affected since it is in relation with the head of the first rib. As a result of a lesion affecting the nerves in relation, many organs and structures some distance from the seat of the disturbance would be affected.

The lesions or **subluxations** of the first rib in nearly every case, consist of an upward and backward displacement of the vertebral end. This increases the obliquity of the rib and the fullness or prominence of the muscles and tissues in relation with the vertebral end. The upward subluxation results most frequently from muscular contracture or spasmodic contraction. The most important muscle is the scalenus medius.

In spasms of the neck and shoulders the rib may be forcibly drawn or forced out of place. The deviation is indicated by the tense condition of the scaleni muscles and the prominence of the rib particularly at the vertebral end. If both upper ribs are involved, the sternum is drawn inward and the clavicles down, so that the space between the clavicle

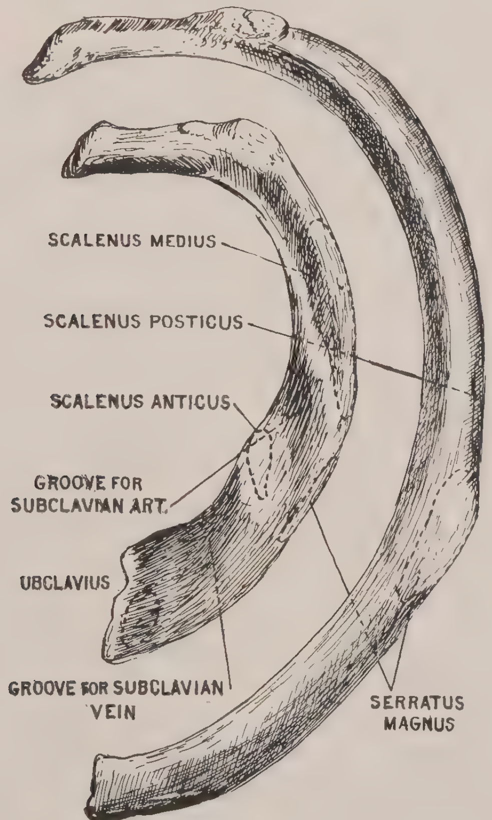

Fig. 118.—Showing the first and second ribs.

and first rib is lessened in size. There is tenderness at the costo-transverse articulation and, in some cases, along the upper surface of the rib. There is disturbance of function of tissues in relation and structures innervated by nerves that are commonly affected by a lesion of the first

rib, viz., the stellate and inferior cervical ganglia and the first thoracic nerve.

The **effects** vary considerably in the different cases. The muscles attached to the rib are usually contractured but this is often a cause of the displacement as well as an effect. The tissues attached to the rib are disturbed, such as the fascia and pleura. Sometimes these effects are manifest only or principally by soreness on deep inspiration. The blood-vessels in relation are disturbed either by direct pressure or contraction of tissues with which they are in relation. Congestion of the spinal muscles, the spinal cord and possibly the upper limb is a common sequel. The **muscles** undergo contracture and the centers located in the eighth cervical and first dorsal segments of the spinal cord, are disturbed as to function. **Pain** in the arm and along the first intercostal space is a sequel. **Heart** disturbances, principally functional in character, are not unusual. This comes from effect on the stellate ganglion which is in relation with the head of the rib. **Lung and bronchial** disorders are more common than heart affections, as a result of this lesion. This is because of the filaments from the spinal and gangliated cords that pass to the lungs and bronchi are impinged by the subluxated rib.

The circulation to the head and face may be disturbed on account of the rib lesion interfering with the passing of the vaso-motor impulses to the head and face, they going over the gangliated cord and ganglia. The **throat** is often affected by this lesion, through the effect on the inferior cervical ganglion and its connection with the laryngeal nerves. A **hacking cough** is very often caused by such a lesion. In the various disorders of the throat characterized by congestion or inflammation, it is advisable to examine the first rib for the suspected cause. It may be that the subluxation is producing the effect by direct pressure on blood-vessels, but I believe these effects result from disturbance of the vaso-motor supply to these parts, which comes to a great extent from the inferior cervical ganglion and spinal cord, the upper thoracic portion.

The **thyroid** gland is in many cases, affected by a subluxation of the first rib. The effect is one of congestion and hypertrophy. The best explanation is that the subluxated rib, by disturbing in some way the inferior cervical and stellate ganglia, interferes with the vaso-motor supply to it, which seems to be principally along the inferior thyroid arteries. The inferior cervical ganglion gives off a branch to this artery and vein which controls, to a large extent, the amount of blood in the

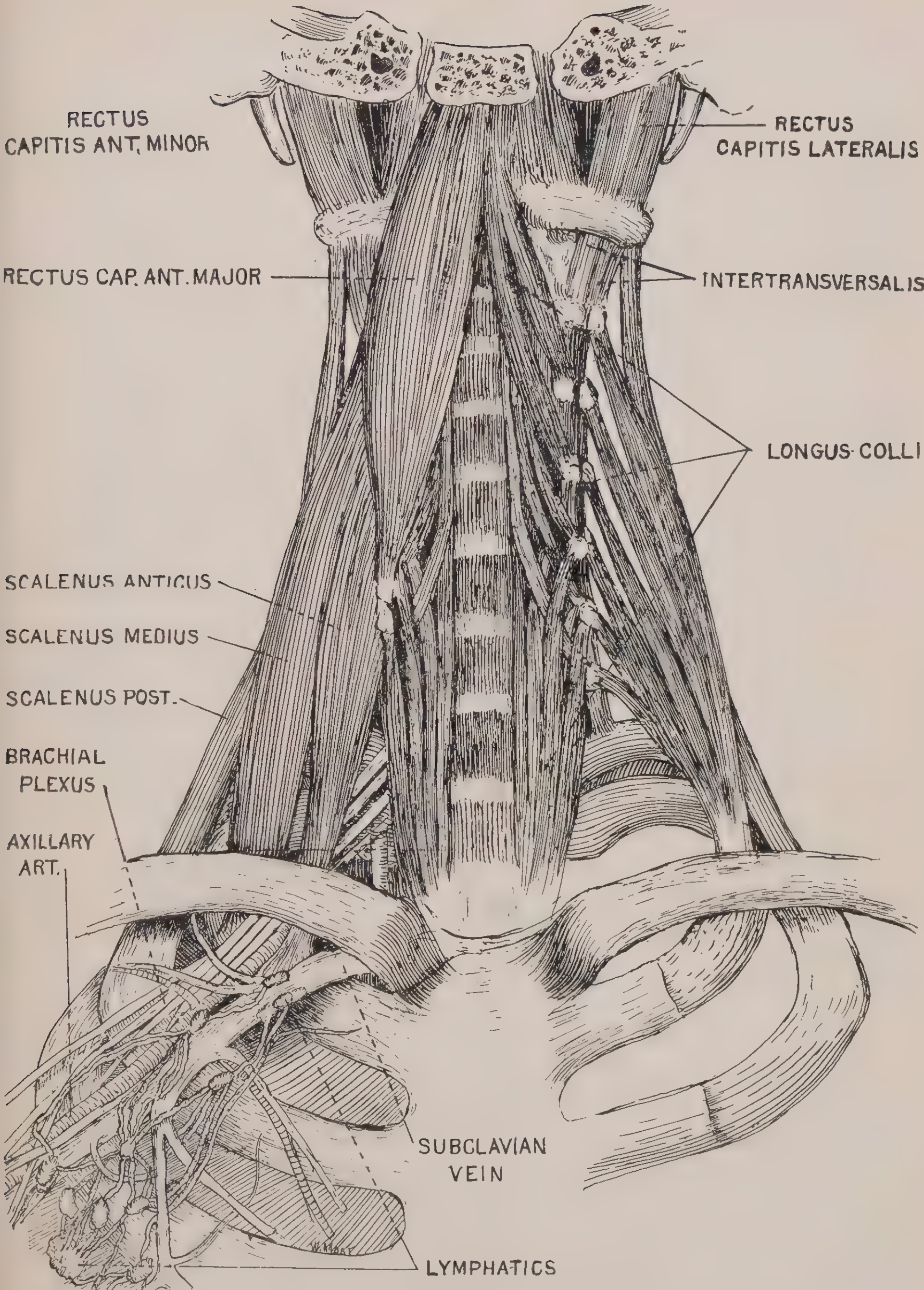

FIG. 119.—Front view of the neck showing the relation of the scalene muscles to the ribs. Note that their contraction will lessen the space between the first rib and the clavicle and thus compress the structures in this area.

gland. The vertebral end of the rib is usually displaced upward and backward, thus forcing the head of the bone against the gangliated cord or directly against the ganglion. This is not the only bony lesion found in diseases of the thyroid gland, but forms the most common and important.

The character and causes of subluxation of the first rib are not rightly understood in many cases, since the contracture of the muscles attached to it is of prime importance, while the usual treatment to "lower" the rib is ordinarily useless in such cases. In other cases, the rib may be displaced from trauma as in a fall, in which the neck is jerked violently to one side or the shoulders thrown upward as in falls on the arms and hands. By the powerful and sudden contraction of the scalene muscles, the rib in such cases, is drawn upward at the vertebral end. In all such lesions, a lowering of the rib is indicated since it is not held out of place by contracture of the muscles yet in some cases, the muscles become contractured on account of the injury to them. Posterior luxations of the first thoracic vertebra are responsible for many of the displacements of the first rib. In the carrying of weights on the shoulders it is possible, in fact common for some change in contour to take place in the upper thoracic vertebræ. As is the case with most rib lesions, the corresponding vertebræ are usually subluxated, which is the cause of the rib lesion.

Lesions along the middle and lower parts of the neck are primarily responsible for the rib disturbance, on account of effect on muscles. On the other hand, many disorders attributed to a displacement of the clavicle are due to upward subluxation of the first rib, as in some affections of the arm.

THE SECOND RIB.

The **second rib** is somewhat larger than the first, but like it, is considerably curved and little twisted. The head has two facets which articulate with the first and second dorsal vertebræ. An angle is present which is external to the tubercle. The shaft presents two surfaces which are almost plane. The upper faces upward and outward. Near the middle of the shaft is a roughened eminence for attachment of the digitations of the serratus magnus. Between this roughened eminence and the tubercle there are attached five muscles: the scalenus posticus, serratus posticus superior, musculus accessorius, the cervicalis ascendens and the levator costæ.

The principal **landmark** of the second rib is its articulation with the sternum, it forming a transverse ridge across the sternum which corresponds to the junction of the first and second parts of the sternum. Posteriorly, it can be indistinctly outlined by pressure at the transverse process of the second dorsal vertebra on a level with the spine of the first dorsal. If the muscles are contractured or if there is much adipose tissue, it is very hard to accurately outline it. The **pleura** is attached to the inner surface of the rib, while to the outer surface are attached the ligaments and muscles which are, in addition to those named above, the intercostals. The intercostal vessels are in relation with this rib and are, in all likelihood, always more or less affected by a subluxation of it, either directly or indirectly, through traction on adjacent tissues.

The **nerves** in relation with the second rib are the second thoracic nerve, with its anterior or intercostal branch, and its posterior division; the sympathetic gangliated cord; the second thoracic sympathetic ganglion and its branches, the pulmonary, cardiac, aortic; and branches that go to the vertebra, ligaments, spinal cord and meninges.

The **movements** of this rib are like those of a typical rib except that they are less marked. Like the first rib, it is fixed by muscular contraction during deep inspiration.

The most common lesion or **subluxation,** on account of the attachments of muscles, is an upward and backward deviation of the vertebral end. The scalenus posticus and levator costæ muscles are attached near the tubercle and by their contracture, the vertebral end will be drawn upward and backward and held in that position. This can be diagnosed by the condition of the muscles, they being contractured; prominence of vertebral end; retraction of sternal end; and by the fact that usually the sternum is also less prominent; tenderness at the costo-transverse and chondro-costal articulations and disturbance of function of structures attached, or viscera innervated by nerves in relation with the rib.

The **effects** of a lesion of this rib are most pronounced in the lungs, pleura, bronchi and second intercostal nerve.

Broncho-pneumonia is dependent, to a certain extent, upon a subluxation of this rib. The lesion may be secondary to repeated colds in which the upper thoracic muscles are always contractured or it may be the result of trauma or sprain. These conditions result in displacement of the ribs, which is usually very slight. The subluxation affects the passing of vaso-motor and other impulses from the spinal and gang-

liated cords to the lungs and bronchi, by producing pressure on the gangliated cord, second thoracic sympathetic ganglion or the pulmonary branches. These impulses arise in the spinal cord, upper thoracic segments, pass out over the anterior nerve roots, common nerve trunk, white ramus, second thoracic ganglion and efferent branches which go to form the posterior pulmonary plexus. On account of the relation of the second rib to these nerves, the connection between the spinal cord and lungs is impaired or entirely broken, hence vaso-motor, secretory and trophic disorders follow.

In **tuberculosis** of the lungs, these rib lesions are present in nearly all cases. They are causative in some cases, while in others they are resultant. Repeated colds produce repeated contractures of the spinal muscles. These contractures interfere with the circulation of blood to the spinal cord and the position of the vertebræ and ribs. The ribs are drawn up at the vertebral end and depressed at the sternal end. The nerves that innervate the muscles of respiration are inhibited, respiration is shallow and the chest movements are lessened; trophic and vaso-motor nerve impulses are to a great extent cut off, and venous congestion of the bronchial circulation with degeneration of the living tissue takes place. The tubercle bacillus, which is ever ready, finds in this devitalized area a nidus favorable for its propagation, hence the disease known as tuberculosis of the lungs.

The explanation of a subluxation of the second rib producing tuberculosis of the lungs is, that the subluxation of the rib interrupts the trophic and vaso-motor lines of communication between the spinal cord and the lungs or else it produces direct pressure on the lung substance.

Pleurisy may be a complication of lung disorders or pleuritis, but in many, is also an effect of a lesion of the second rib. The explanation is (1), that the displaced rib presses directly on the intercostal nerve, thus producing pain in the parietal layer of the pleura to which it is distributed, and (2), since the pleura is directly attached to the rib a subluxation of the rib, however slight, would produce traction on, or injury in some way to, the pleura. **Bronchitis** is often the result of lesions of the upper ribs. Chronic bronchitis with cough is in most cases the result of a subluxation of the second or third rib. The reason for it is the fact that these rib lesions disturb the innervation of the bronchial tubes which are almost entirely innervated by way of the pulmonary plexus. Chronic cough of a bronchial nature,is the result of irritation of the sensory nerves

lining the tubes, the irritating factors being congestion and hypersecretion of the bronchial mucous membrane. It may be due to irritation of the pleura or lungs, the cough being an attempt on the part of the body to eject or otherwise rid itself of the irritating factors. The motor nerves supplying the bronchioles may be affected by this rib lesion and the size of the lumen changed. If the nerves are stimulated the bronchioles contract and the condition is called asthma on account of its effects on respiration. The coughing is due to irritation of the bronchial mucous membrane and that lining the larynx as well. The different parts of the respiratory tract are correlated so that a disturbance of one part will usually manifest itself in another part of the same tract. It is a well known clinic fact, that chronic cough, bronchial or laryngeal, in most cases, comes from a subluxation of the second rib, but may be a reflex effect of many visceral disorders and irritation applied to distant parts.

Many impulses arising in the upper part of the thoracic spinal cord pass out over the white rami into the gangliated cord, thence upward to the head and face. These have been described before. (See second thoracic segment). These impulses supply blood-vessels, glands, mucous membranes and muscles with vaso-motor, secretory, motor,and trophic impulses and possibly control sensation. In this connection should especially be mentioned the circulation of the brain, the pupil of the eye and the salivary glands, the submaxillary in particular.

Congestive headaches often follow subluxation of the second rib especially on the left side. The explanation is, (1), that the vaso-motor impulses to the various cerebral vessels are inhibited by pressure of the head of the rib on the nerve trunk conveying these impulses, hence dilatation of the blood-vessels of the head, and (2), this lesion in addition, may excite the cardiac accelerators, which condition results in the forcing of more blood into these already dilated vessels of the brain.

Displacement of the second rib is associated in some cases with mammary disturbances. Extirpation of one breast causes a weakness of the eye on the same side. The connection is through the upper spinal segments. A subluxation of the second rib will interrupt this connection, or perhaps in some cases, irritate the nervous mechanism, since the nerves tracts or trunks are in relation with the rib and are subject to pressure when the rib is out of its normal position. The mammary gland may be affected in different ways by this rib lesion. Imperfect or non-development, mastitis and disturbances of secretion and nutrition can

be rightfully attributed to disorders of the upper ribs. The explanation is that the rib lesion disturbs the innervation of the gland, which comes by way of the intercostal nerves.

The **arm** on the same side is often affected by a lesion of the second rib. Most of the trophic and vaso-motor impulses to the upper extremity come from the upper thoracic spinal cord. These impulses pass out

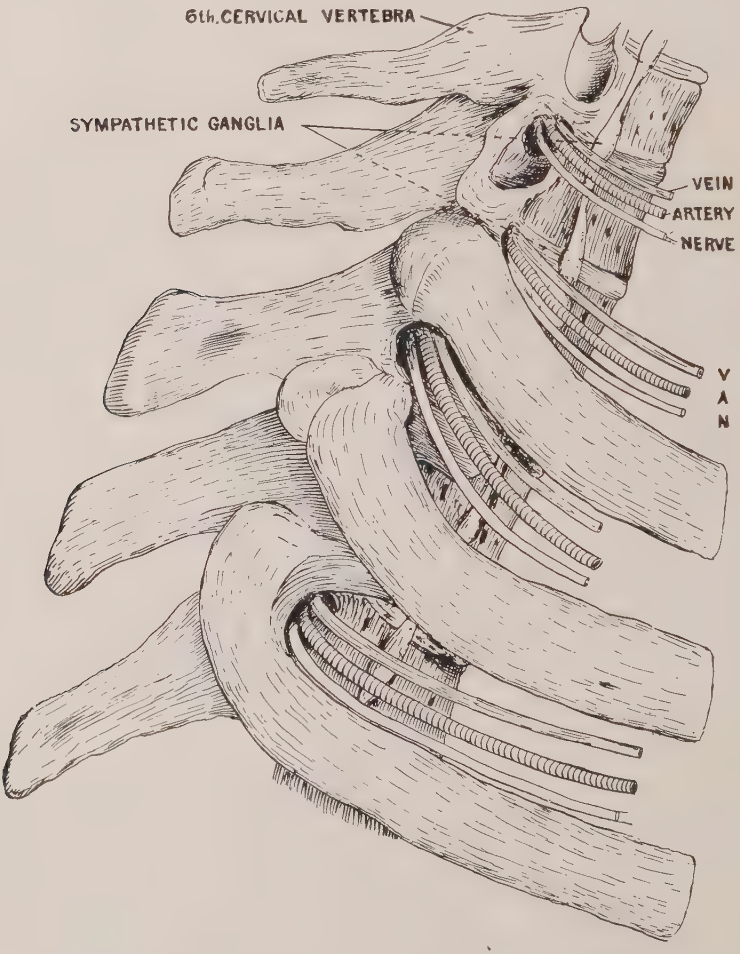

Fig. 120.—Showing the relation of the structures in the intervertebral foramina to each other and to the ribs and vertebræ.

from the spinal cord over the anterior nerve roots, through the intervertebral foramen over the common nerve trunk and reach the arm by passing into and up the sympathetic gangliated cord and over the brachial nerves. This cord with its second thoracic sympathetic ganglion, is in relation with the head of the second rib. In all subluxations of the rib, the head of the rib is changed as to position and often presses, directly or indirectly, on the gangliated cord, thus interfering with the line of communication connecting the upper thoracic segments of the spinal cord and the arm.

The **muscles** attached to the rib and those innervated by the nerves in relation with the second rib are affected by this lesion. If contractured, which they will be if the lesion is irritative, their function is disturbed, circulation through them altered and a sense of ache usually accompanies the condition. In acute cases there may be a distinct pain which will ascend to the back of the neck and head. In occupation neuroses, an ache is very commonly found between the shoulders or on the affected side. Relaxation with atrophy and weakness may follow instead of contracture, but irritation seems to be the usual primary effect of a typical subluxation of any bone.

In recent cases of a subluxated second rib, **pain or ache** along the course and distribution of the second intercostal nerve, combined with a dry, **irritative cough** often leads to the diagnosis of tuberculosis of the lungs. Deep inspiration is painful, the patient is drawn forward to better shield the affected side, circulation through the lungs is lessened in amount and rapidity, and the patient has the general appearance of a consumptive. In some cases tuberculosis develops but can be prevented by the proper treatment, which consists of correction of the rib lesion. Tenderness on pressure along the course of the second rib is present in practically all lung affections. The intercostal nerve and its branches are congested in such cases as well as the tissues in relation. Tenderness here may be the result of over use of the intercostal and serrati muscles.

THE THIRD RIB.

The **third rib** is classed with the typical ribs, hence needs little, if any, separate mention. It is longer, more twisted and curved than the second, but not so much so as the fourth rib. Its external surface faces more nearly directly outward than that of the second rib. The sternal

end can be readily located by refering to the sternal end of the second rib which forms a ridge on the sternum at the junction of the first and second portions. The third intercostal space is the largest, and unless this is remembered when making a physical examination of the chest, it might be regarded as an abnormality. The second intercostal space is next in size.

This rib gives attachment to the **pleura** and the various **chest muscles.** Among the most important are the levator costæ, serratus magnus and intercostals. The third intercostal **artery and vein** are in relation with the shaft and head. The third thoracic **nerve** with its anterior and posterior divisions, the sympathetic gangliated cord, and the third sympathetic ganglion with its branches, are also in relation. The viscera in relation are the heart on the left side, and the lungs.

The **movements** of this rib are not so marked as those of ribs lower. They consist of a rolling and gliding movements at the costo-transverse articulation. There is some rotation at the head but the movement here is less than at the costo-transverse articulation. The rib is thus everted and elevated at the sternal end and with this, all the diameters of the chest are increased.

The third rib is a typical one and on this account, its lesions are typical and the kinds of lesions and their description that apply to this rib, will apply to all of the true ribs. The subluxations of this rib vary but the most common is the one in which the rib is drawn up at the vertebral end and inward and downward at the sternal end. This sort of displacement is characterized by increased obliquity of the rib; depression at the sternal end, it being displaced slightly inward and downward; undue prominence of the tubercle which is due to the displacement upward at this point so that it is the more easily palpated, and to a great extent this prominence is due to the ligamentous thickening at the costo-transverse articulation; increased prominence of the lower edge; a lessening in size of the interspace below at the sternal end and increase in size of the corresponding space at the vertebral end; tenderness at both ends and often along the lower edge of the rib; and disturbance of function of the rib so that its movements are impaired and painful. The function of the costal joints, like that of any joint is movement and in diagnosing any osseous subluxation, a test of the mobility should be made. This is done in the case of the costal articulations by causing the patient to fill the lungs to their utmost capacity. In practically all rib subluxations

that are really causing trouble, unless it is a very chronic case, there will be some sort of pain or discomfort on deep respiration since the movement of the rib is greatest in deep inspiration. In chronic cases, the movement may only be restricted and not necessarily painful.

The rib may be displaced upward at both ends. This is diagnosed by the change in the intercostal spaces, the one above being lessened and the one below increased, throughout their entire course.

A twisting of the rib is indicated by prominence of one of the edges it depending on the character of the twist as to the edge involved. The most common type is an upward twisting in which the lower edge is thrown outward. Such subluxations are diagnosed by the prominence of an edge.

It is possible for the vertebral end to become displaced downward from trauma or severe sprain of the body, this displacement could scarcely result from muscular contracture on account of the direction of the muscle fibers attached to the rib.

In all rib lesions, it is well to remember that both ends of the rib are affected but the degree of movement is greatest at the sternal end. Inflammatory material collects around the vertebral end in traumatic cases and is responsible for many of the effects. There is an enlargement at the articulation which can be palpated in the case of the costo-transverse joint.

The effects of a lesion of the third rib vary with the degree of the subluxation, length of standing, cause of the lesion and condition of the body. It directly affects the pleura, lungs and possibly the pericardium and heart by pressure. Through disturbance of nerves, it will affect the head and face, arm, lungs, bronchi, heart, mammæ, spinal cord and muscles of the back in relation. **Pleurisy** is an effect because of direct irritation of the pleura. Pneumonia and pulmonary tuberculosis result because of the effect on the nerve supply to the lungs, the sympathetic cord being affected by the subluxation partly from pressure of the rib and partly from the inflammatory material.

Angina pectoris and the various functional disorders of the heart, result because the displaced rib produces pressure on the third sympathetic ganglion, thus interfering with the connection between the cardiac centers in the spinal cord and the heart. The head and face receive impulses from the spinal cord as low as the third dorsal.

A lesion of the third rib interferes with the nervous connections as well as the activity of the spinal cord centers by pressure on the gangliated cord. The centers for the arm are as low in the spinal cord as the fifth dorsal and the lesion of the third rib will break the line of communication between these centers and the arm.

The **mammary gland** is affected from disturbance of the intercostal nerves and blood-vessels. The **muscles** in relation are contractured or relaxed by a lesion of this rib on account of effect on the third pair of thoracic nerves. The **spinal cord** is disturbed by the lesion through its effect on the blood-vessels that supply it, particularly the veins. The veins draining the cord are in relation with the ribs, and any deviation will more or less affect the drainage.

THE FOURTH RIB.

The **fourth rib** is slightly longer, more twisted and more curved than the third. It is of greatest importance on account of the frequency of its lesions, in relation to heart and pleural affections. The sternal end is most easily located by noting the position of the nipple, it being on the rib, or by counting down from the second rib which can always be found on account of the ridge across the sternum.

The **movements** are a little more marked than those of the third and it is oftener subluxated than the ribs above. It has in relation with its principal articulations the costo-vertebral and costo-transverse, the fourth sympathetic ganglion with its branches, and the fourth pair of thoracic nerves and their anterior and posterior divisions, the recurrent meningeal nerve, the rami communicantes and the various arteries and veins going to and from the spinal cord and thoracic structures.

Perhaps the structures most easily and most frequently affected of those named above, is the **vein** which drains the spinal cord and muscles. Any or all of them are more or less affected in a typical case.

The lesions or subluxations of the fourth rib are like those of a typical rib, the most common form consisting of an upward movement of the vertebral end, while the sternal end is drawn downward and inward, and with this there is rotation so that the lower edge is brought into prominence and the intercostal space above is enlarged at the sternal end. There is tenderness at all its articulations and usually a thickening of the ligaments, which is most marked at the costo-transverse joint.

Affections of the **heart** are the most common effects of a subluxa-

tion of the left fourth rib, while lung, pleural and bronchial disorders often result from a lesion of the fourth rib on the right side. Angina pectoris, especially the false type is in almost, if not all cases, due to a lesion of this rib. The reason for it is that the innervation of the heart is by way of the sympathetic ganglion and its efferent branches, all of

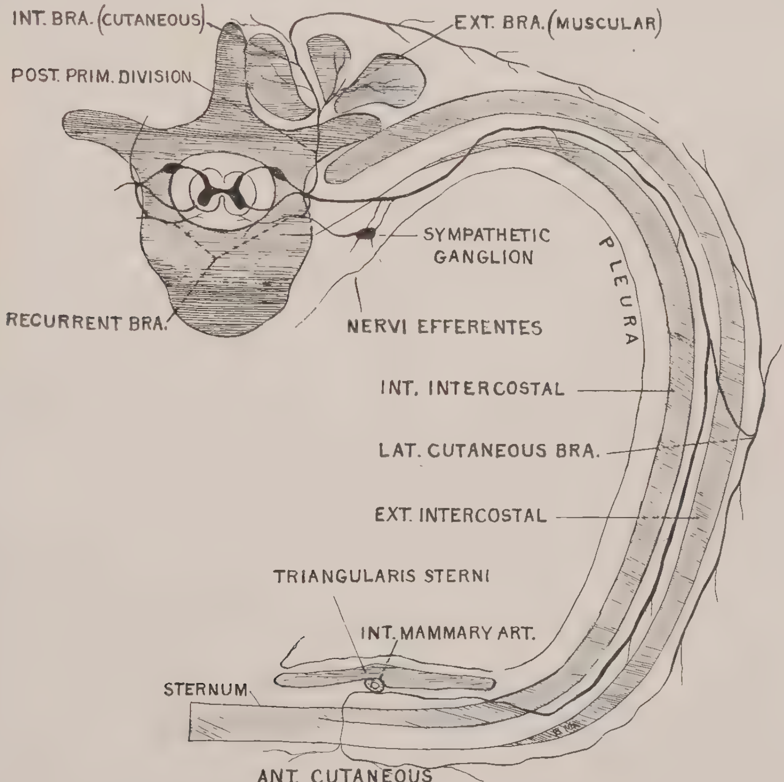

FIG. 121.—Showing origin, course, relations and distribution of a typical thoracic nerve.

which are in relation with the head of the fourth rib. The efferent impulses come primarily from the spinal cord (the fourth segment in particular). The fourth intercostal nerve is also derived from the fourth segment of the spinal cord. An irritation applied to the sympathetic ganglion or cord will cause the pain to be referred to the cerebro-spinal

nerves in close relation, which, in this case, is the fourth thoracic and its branches. The pain in angina pectoris seems to be mostly in the intercostal nerves while some of it is in the posterior division, in the ulnar and possibly the pneumogastric and cardiac plexuses. In some cases, the rib undoubtedly presses directly on the heart, thus interfering with its contractions. In true angina, there seems to be a disturbance of nutrition of the heart, which is due, partly at least, to a lesion of the fourth rib. The entire left side of the chest becomes tender and remains so nearly all the time. This signifies that the intercostal nerves are congested or slightly inflamed. This is the result of some vaso-motor disturbance, principally at the vertebral end, or the drainage is interrupted, thus leaving the nerve engorged with blood or otherwise stimulated Nearly all pain is due to pressure on a nerve, the most frequent form of pressure being congestion of blood in and around the nerve. This congestion is, in many instances, I believe, the result of muscular contractures. Again, angina pectoris may be the result of some disturbance of the accelerator cardiac nerves which causes painful contraction of the heart, as in the case of the stomach, uterus or small intestine. We do know that in nine-tenths of all cases of angina pectoris there is a lesion of the fourth or fifth rib on the left side and that the correction of the lesion brings relief. We also know that in such a lesion, the cardiac accelerators, the sensory cardiac, also the trophic and vaso-motor nerves to the heart are in relation with the rib and would be disturbed by a lesion of the rib. We also know that these nerves connect with the fourth intercostal. Our premises being true, since they have been proven by clinical experience, the conclusion is that the rib lesion produces angina pectoris by (1) producing pressure on the nerves connecting the spinal cord and heart, thus interfering with the motor, sensory, trophic and vaso-motor impulses; (2) by producing pressure on or irritation of the fourth or fifth intercostal; (3) or by producing pressure directly on the heart, thus lessening the space in which it has to beat.

Conditions usually described by the layman as "smothering spells." are also due to lesions of the fourth or fifth rib on the left side. They produce effects in two ways: (1), by pressure on the heart, and (2), by disturbing the motor impulses so that the heart has great difficulty in beating, which condition is always accompanied by dyspnea or a choking sensation.

Palpitation is another form of heart disorder that follows a

lesion of the fourth rib on the left side. The subluxated rib in some way interrupts or otherwise impairs the motor supply of the heart so that the amount of nerve force varies instead of being regular. The rapidity of contraction of the heart is determined by the number and intensity of the motor impulses sent to it; in other words, the contrac-

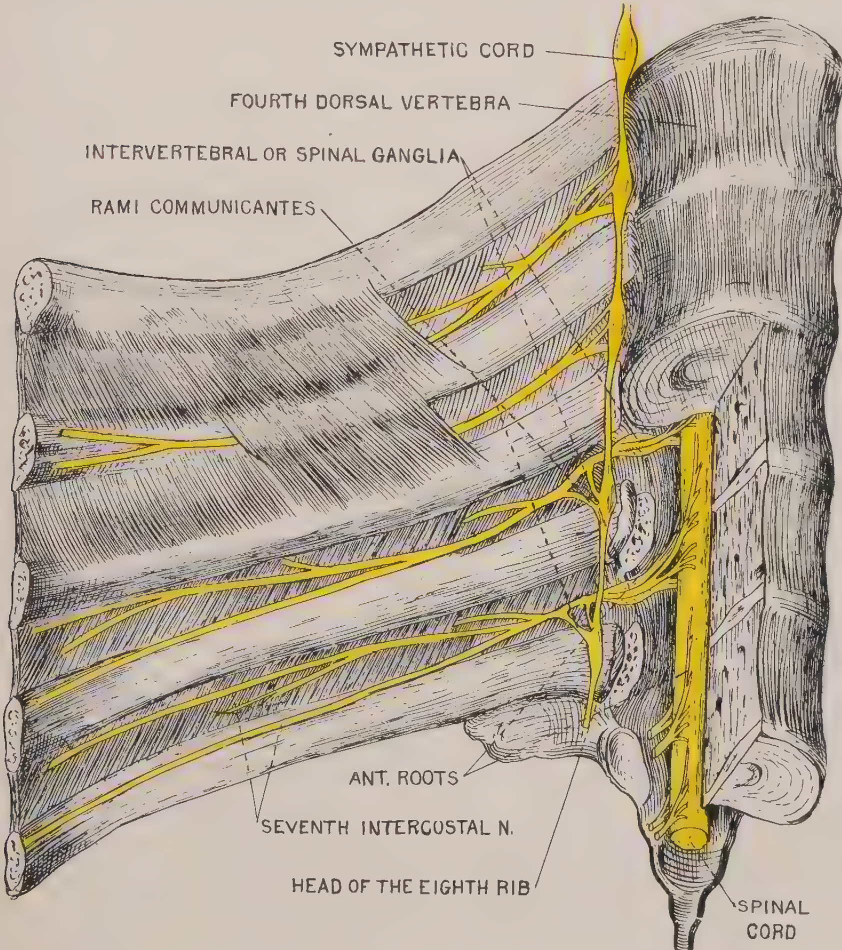

FIG. 122.—Showing the relation of the gangliated cord and its branches, to the heads of the ribs. A portion of the bodies of the vertebræ has been removed thus exposing the spinal cord and its nerves. Rib lesions affect these nerves.

tion in an effect. The rib lesion, by stimulating the cardiac nerves, increases these impulses, hence an effect in proportion to the degree of stimulation. The nerves become more irritable, responding to any stimulation, as from exertion, fright, etc. In short, the displaced rib affects the motor supply of the heart by pressure on the gangliated cord, the rami communicantes, nervi efferents, or it affects the cardiac centers in the spinal cord by interfering with the circulation of blood through them.

Arrhythmia is explained in a similar way. The nerve feed to the heart is not regular, hence the contractions of the heart are not regular. The interruption of the nerve impulses is caused partly by the rib pressing on the nerve over which the impulses pass, viz., the white rami, sympathetic gangliated cord or the nervi efferentes. What is known as an irritable heart is the result of a similar condition. The nerve supply is unstable, irregular and subject to increase from almost any exciting cause. The rib lesion is the cause, as it interferes with the passing of various impulses to the heart.

In some dissections made by the author it was found that some of the efferent branches of the upper thoracic ganglia passed forward directly into the pneumogastric nerve. These fibers were traced down the sheath of the nerve and finally appeared to form a component part of the tenth. This condition very materially helps the explanation of why upper thoracic and rib lesions affect the heart, producing palpitation, arrhythmia and other disorders. In all cardiac affections the fourth and fifth ribs on the left side should be carefully examined, since clinically, lesions of these have been found in nearly all cases. Even in organic heart disease these ribs are found to be in an abnormal condition.

Mammary disorders, such as non-development, tenderness, mastitis, ulceration, abscess, tumors and disturbances of milk secretion, often result from a lesion of the fourth rib on the same side. The explanation lies in the fact that the innervation, blood supply, drainage and lymphatic vessels are in relation with the fourth rib, as well as the gland itself. A displacement of the rib, however slight, will in some way affect the gland directly or indirectly through the effects on the blood supply and innervation. Many cases of ulceration that had been diagnosed as cancer, have been cured by adjusting a rib that intercepted the venous drainage of the breast, thus causing the blood to stagnate and undergo decomposition.

Disorders of the lungs and pleura arise from a subluxation of the fourth rib. They are similar to those arising from a lesion of the third rib, hence do not merit a separate description here. Pain or ache between the scapulæ is most often the result of a rib lesion, the fourth being most frequently out of place, in such cases. The explanation is that the deviated rib produces an impingement on the posterior division of the fourth thoracic nerve. This division passes through a ligamentous foramen formed by the costo-transverse ligaments and this foramen is usually lessened in size by the rib lesion. As a result either the sensory filaments are directly affected or else muscular contractures arise from irritation of the motor filaments. A lesion of the fourth rib may also produce an inflammation of the intercostal nerve or what is commonly called "shingles." This, however, may follow lesion of any rib.

THE FIFTH RIB.

The **fifth rib** is a typical one and differs in appearance and shape in no particular from that of the fourth. It is slightly longer, a little more curved and quite commonly dislocated and fractured. It furnishes a landmark for the heart (apex beat) and its subluxation is the cause of many sensory disturbances usually referred to the lungs and heart. It has in relation with it the usual intercostal vessels and nerves, all of which are more or less involved by a subluxation of the rib. The most important muscles attached to it are the levator costæ and serratus magnus. A lesion of this rib especially affects its movements, thus hampering respiration, making it painful and shallow.

The **pleura** is attached to this rib and is the seat of much of the pain which comes from the rib lesion. In lobar pneumonia this is particularly marked. The **viscera** in relation which would be affected by the lesion are the lungs, heart and sometimes the stomach. The right fifth rib may by its displacement affect the liver. The lungs and heart are affected in a way similar to that in lesions of the fourth rib. Also the mammary gland is affected (see fourth rib). The special points to be remembered in connection with a lesion of the fifth rib are (1), pleurisy,or what is commonly called a catch in the side; (2) functional disorders of the heart when the left fifth rib is involved; (3) affections of the lobes of the lung, and (4), disturbances of that part of the chest wall, as in lobar pneumonia. The fifth rib is more often fractured than any other on account of its position, it being most exposed of all the true ribs.

FIG. 123.—Showing the course, relation to ribs, and distribution of the intercostal nerves.

In experiments performed on dogs, *McConnell states: "Under anesthesia the dog's middle and lower dorsal region was sprung forward with fairly moderate force.

Six weeks later dissection revealed an anterior "break" between the tenth and eleventh dorsal vertebræ. Also, the fourth and fifth ribs on the right side were sprung upward at the vertebral ends. Muscles and ligaments over and between the injured vertebræ and ribs, very tense and rigid.

Macroscopic hemorrhagic spots from the size of a pin-point to head of a pin were found in the sympathetics opposite the "break" and in the corresponding rami on both sides. Congestion of spinal nerves between the tenth and eleventh ribs.

Stricture in the lower third of the jejunum.

The microscope revealed pathological congestion of the above affected nerves, that is, intracellular congestion."

THE SIXTH RIB.

The **sixth rib** is slightly more obliquely located than those above, its costal cartilage is longer and forms a more acute angle with the sternal end of the shaft. The interspaces are not so wide, decreasing in size from the third down. The sixth intercostal vessels are in relation with this rib, a groove being formed for them on the under surface of the rib. The vein is most easily affected. The sixth intercostal nerve, the gangliated cord, sixth thoracic ganglion, great splanchnic nerve and the rami are also in relation. The pleura, liver and stomach are in relation and are affected by direct pressure in inward subluxations, or what is usually called, a depressed condition of the rib. This rib is subject to the usual rib subluxations and the diagnosis is based, as in other ribs, on effects; position and comparsion, with other ribs.

The **sensory** effects are characterized by disturbances of sensation in region supplied by the sixth intercostal and its branches and in the region supplied by the posterior division of the sixth thoracic nerve. The lesion is most commonly an irritative one, therefore pain is the most common of the sensory effects. The pain is felt at the sternal end of rib, along the lateral cutaneous branch and at the vertebral end. The integument is tender to the touch and respiration is "catchy." There may be numbness or complete anesthesia in the same areas. The

*Journal of A. O. A., Vol. V, p. 16.

explanation of these sensory effects lies in the fact that when the rib is displaced it presses on or otherwise irritates or affects the sixth thoracic pair of nerves. In some instances the pain or ache is undoubtedly due to the congestion of the nerve which results from the subluxated rib.

There will be some **thermic** effects along the sixth intercostal space in a lesion of the sixth rib. The surface temperature is most commonly lowered. Some disturbance of the sensibility of the liver and stomach result from this lesion, since the afferent impulses from these viscera pass through the sixth ganglion which is in relation with the head of the rib and would be disturbed by a lesion of the rib. If the impulses are increased, there will be pain either in the viscus or in the cerebro-spinal nerve—the sixth intercostal. This nerve is the seat of pain in a great many visceral disturbances, especially of the stomach and liver, the pain being a referred one and is explained by Head's law. The muscles of the back and chest supplied by the sixth thoracic segment, become tender as a result of the contracture and irritation of the muscular sensory nerves.

The **motor** effects of a lesion of the sixth rib are muscular contractures and perverted peristalsis of the liver and stomach. The muscles in relation with the rib and those supplied by the sixth thoracic segment, become contractured in cases of lesion of the sixth rib. This is the result of irritation (fatigue or over-stimulation) of the motor nerves or the result of traction on the muscle. The **motor impulses** that pass to the **liver** and **stomach**, in part **pass through** the **sixth thoracic sympathetic ganglion.** A lesion of the sixth rib will interrupt or in some way disturb the function of the ganglion, hence some motor effect in the above named viscera. If the lesion irritates the ganglion, splanchnic nerve or ramus, there is usually excessive peristalsis in the viscus supplied. This lasts as long as does the stimulation, after which the opposite effect sets in. If the lesion is paralytic, the opposite result will occur. Experimentally, it seems that stimulation of the splanchnic nerves causes a lessening of peristalsis in the viscera, while inhibition produces the opposite effect. Clinically, it is proven that inhibition applied to the spine will tend to lessen peristalsis if the parts are not in a normal condition. The more nearly normal the parts the less the effect of either stimulation or inhibition. After all it is a question of adjustment. If the rib lesion is causing an irritation and the disturbance is overcome, whether by stimulation, inhibition or some other means, the effect must be the same, that is inhibitory. If the rib lesion is producing an inhibitory effect,

correction of the lesion will necessarily produce a stimulation, regardless of the way in which it is corrected.

A lesion of the sixth rib will cause a **lessened** or **increased secretion** in the **liver, stomach** and **sweat glands,** it depending on the character of the lesion, that is whether it is irritative or paralytic. In the casė of the viscera, secretory impulses pass from the spinal cord by way of the sixth thoracic sympathetic ganglion, thence over the great splanchnic. A displacement of the sixth rib will intercept or stimulate these impulses. If they are intercepted, secretion is lessened although it does not depend entirely on the secretory nerves, but in part upón the quantity and quality of the blood. If they are stimulated, secretion is increased. This is true experimentally in cases in which the parts are in a healthy condition. Clinically, it seems that the opposite is true. This is best demonstrated in catarrh of the stomach. There is a sort of paralytic condition of the spinal muscles, stomach, and in fact all the tissues in relation. The accumulation of mucus in the stomach may be due to weakness of the muscles of the stomach wall, the peristalsis not being strong enough to expel it, but I am of the opinion that there is a **hypersecretion of mucus,** and that the lesion produces inhibition rather than stimulation.

Excessive secretion of **sweat** along the sixth interspace is explained by the rib lesion disturbing the function of the sixth intercostal nerve, one of its functions being that of carrying secretory impulses from the sixth ganglion to the sweat glands in the integument over the sixth interspace.

Vaso-motor impulses to the intercostal arteries, spinal branch, muscular branches to the spinal muscles, and the various abdominal arteries supplied by the great splanchnic nerve, pass through the sixth thoracic sympathetic ganglion and white rami and would be involved in a typical lesion of the rib. Congestion of the parts supplied by the arteries named above will result if the lesion inhibits the passing of the vaso-motor impulses, while anemia will result if the lesion is irritative. The **veins** are similarly supplied with vaso-motor impulses and will be affected by this lesion. The **venæ azygi** are also affected by this lesion, through disturbance of their innervation, and since these veins drain the spinal column, cord, thoracic wall and muscles of the back, disturbances of these parts are common.

The **trophic effects** of a rib lesion are noted in muscles, bones and

other tissues supplied by the sixth intercostal, the recurrent meningeal, and the sixth thoracic sympathetic ganglion. All nerves are more or less trophic to the parts supplied, hence any disturbance of the above named nerves will produce some trophic effect. The muscles suffer most and soon the median furrow becomes widened, the ribs begin to prolapse, the antero-posterior diameter of the chest decreases and respiration becomes shallow. Necrosis of the rib is sometimes a sequel to the lesion. Weakness of the walls of the stomach is also a trophic effect of the lesion.

*McConnell states in experiments on dogs: "Two weeks after operation dissection showed the fourth, fifth and sixth ribs on the right side dislocated upward at the vertebral ends.

The usual muscular tension and rigidity of the spinal ligaments in the area affected.

Marked inflammation and hemorrhage of the sympathetic chain, the rami, posterior spinal nerves, the intercostal, the posterior and anterior nerve roots, the meninges of the cord for a diameter of a quarter of an inch surrounding the exit of the fifth spinal nerve on the right side. and along the anterior commissure. The pathological condition here was exceptionally marked. The dog was sick and inactive for a week following the first forty-eight hours after the operation.

Enlargement of spleen to over twice the normal size."

THE SEVENTH RIB.

The **seventh rib** is the lowest of the true ribs. Its costal cartilage is longer than that of the ribs above. Its relations, lesions and effects of lesions, are similar to those of the sixth rib. When subluxated, the muscles attached to it are either relaxed or contractured. Those affected are the levator costæ, serratus magnus, intercostals, the abdominal muscles and the diaphragm. All of these muscles have to do with respiration, therefore in a lesion of the seventh rib, respiration is disturbed.

In relaxation of these muscles, prolapsus of the ribs results. In contractures of the muscles, normal movements of the ribs are impaired, while in some cases the rib is drawn out of place. A lesion of the seventh rib will, in some cases, produce relaxation of these muscles; in others, contracture, on account of (1) attachment of these muscles to the rib, and (2) through disturbance of the seventh pair of thoracic nerves.

*Journal A. O. A., Vol. V, p. 16.

The **blood-vessels** affected by this lesion are the intercostal vessels with their spinal and muscular branches, the gastric and hepatic vessels. Clinically, it seems that the veins are affected more often and more readily than the arteries. As a result there may be anemia or congestion of the muscles of the back, seventh intercostal space, pleura, spinal cord, stomach and liver. The explanation is that the lesion exerts pressure on some of these vessels, while others are affected through their innervation which is by way of the seventh thoracic ganglion and great splanchnic.

The **nerves** affected by a lesion of the seventh rib are the seventh thoracic spinal nerve with its posterior and anterior, or intercostal branches, the recurrent meningeal nerve, the gangliated cord and the seventh thoracic sympathetic ganglion with its branches, viz., the great splanchnic, aortic, and filaments to the vertebræ and ligaments. The lesion may stimulate or inhibit the passing of impulses over these nerves. There may be relaxation of contracture of the muscles supplied by the seventh dorsal segment or sensory disturbances in the integument of the back and the seventh interspace. The pleura is usually involved, partly through its nerve supply and partly on account of its attachment to the rib. The passing of impulses over the great splanchnic is disturbed, hence vaso-motor, secretory, motor, sensory and trophic disturbances, most commonly found in the stomach and liver. All of these nerves are in relation with the seventh rib, or the impulses passing over them pass over nerves that are in direct relation; that is, the impulses passing over the great splanchnic, also pass over the rami, gangliated cord, and common nerve trunk of the seventh thoracic pair of nerves and are in relation with the head of the seventh rib.

The **viscera** affected by a lesion of the seventh rib are the stomach and liver, the seventh rib on the left affecting the stomach, while a lesion of the corresponding rib affects the liver. This may be explained in two ways: (1), relation of the rib to the viscera, and (2), relation of rib to the nerve supply to them. These effects vary in that the lesion in one case is irritative, while in another it is inhibitive. Thus it may produce excessive peristalsis, activity and pain; or lessened peristalsis, lessened activity and a general paralytic condition of the viscera.

The spinal cord, spinal column, ligaments and muscles are also affected by the lesion. Indigestion, biliousness, pleurisy with respiratory disorders complicate acute cases. The **diaphragm** is also disturbed in

that its position is changed, its openings altered in size and its contractions hampered. The author has had some experience with cases of hiccough in which the trouble was caused by a lesion of the lower ribs, the seventh being at fault. The lesion seemed to irritate the diaphragm, and as a result the attack came near terminating fatally. By lifting the rib, that is by correcting the rib lesion, the irritation was relieved and the hiccough ceased immediately. The importance of this sort of lesion in the persistent types of hiccough is underestimated, since in many of them the ribs that give attachment to the diaphragm are often found to be in a state of descent, or more commonly a single rib is twisted in such a way that it has an irritative effect. The explanation is based (1), on attachment of the muscle (diaphragm) to the rib, and (2), irritation of the intercostal nerves which help to innervate the diaphragm. Thermic changes, the interspace becoming cold, and localized perspiration are often associated with the lesion of the corresponding rib. I have often found a lowering of the surface temperature along the seventh and eighth interspaces on the left side in chronic catarrh of the stomach.

The sternal end of the rib is subject to irregularities in that the cartilage is often forced upward or outward. In rickets and adenoids of the throat, there is often found a depression or shallow, wide groove corresponding to the upper attachments of the diaphragm to the chest wall.

THE EIGHTH RIB.

The **eighth rib** belongs to the false ribs, so-called because it does not articulate directly with the sternum, but with the cartilage of the seventh rib. The false ribs have a greater range of mobility and are more elastic than are the true ribs. The obliquity is greater and this is often decidedly increased in cases of general weakness and from tight or improperly worn clothing.

The **movements** of this rib are upward and outward in inspiration and downward and inward in expiration. In all lesions of this rib these are impaired, in acute cases made painful, while in the chronic they are lessened, this resulting in descent or prolapsus. The lesions of this rib are similar in character to those above, torsion and depression of the sternal with elevation of the vertebral end, being the most common. In this sort of displacement the lower edge is turned outward to such an extent that it can be readily palpated. The interspace below at the sternal end is decreased in size, while that above is increased.

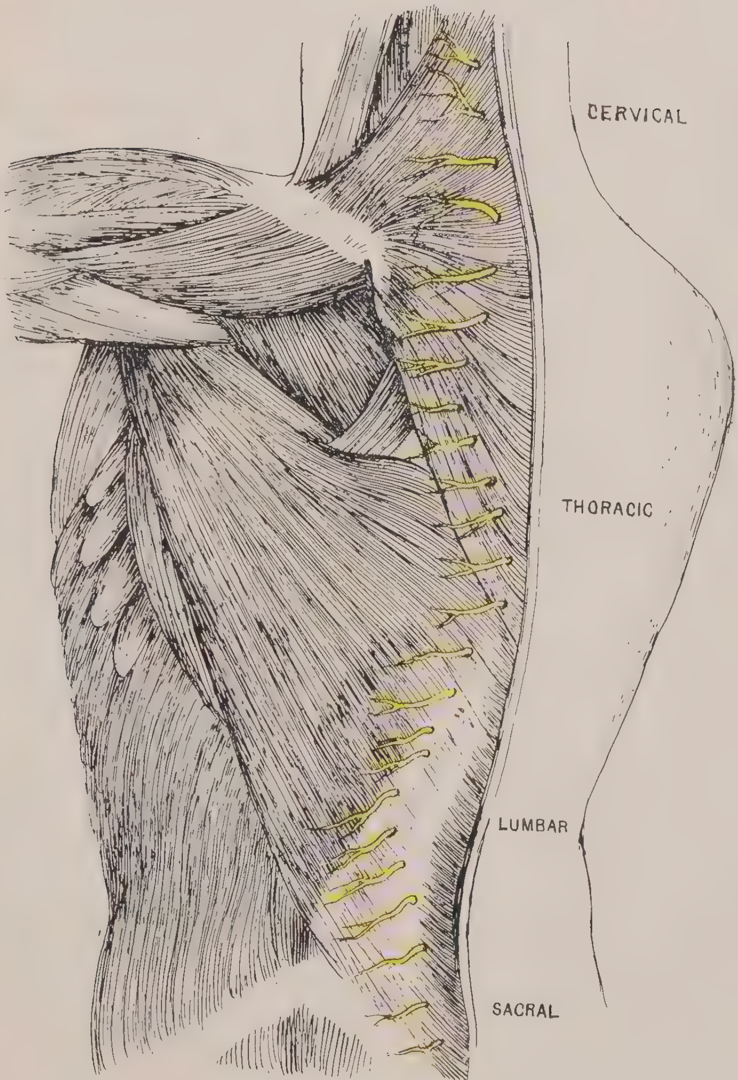

FIG. 124.—Drawn from a dissection at the A. S. O. to show the thickness of the skin of the back and points of emergence of the cutaneous nerves. Note the arrangement of the muscle fibers.

The **effects** of a lesion of this rib, vary with the degree and length of standing of it. The **sensory** effects are most common and important from a clinic point of view and will be considered first. The sensory nerves involved directly are the eighth thoracic with their branches, the anterior and posterior divisions. The gangliated cord in relation contains some afferent fibers that convey impulses from the abdominal viscera to the spinal cord, thence by it on to the sensorium. This **afferent tract** is impaired by a lesion of this rib and on this account, the sensibility of the viscera is increased or decreased by it. Pain from visceral irritation is often referred to the cerebro-spinal nerves branching from the segment that supplies the viscus, as in hepatic colic. The converse is also true that is, pain in the viscus is produced by the irritation caused by the subluxated rib.

Painful affections of the **liver,** are caused in some cases by this lesion. Pain in the **pleura**, in the eighth interspace and in the intercostal muscles in relation, is the result of this lesion irritating the eighth intercostal nerve, since it supplies these structures. These sensory disturbances cause respiration to be imperfect, jerky and shallow. There may be a perversion of function of these sensory nerves, this producing tingling sensations or, what is technically called, **formication.** There may be **numbness** of the parts or other sensory disturbances that commonly result from inhibition of a sensory nerve. All these sensory effects are explained by the relation of the sympathetic cord, eighth thoracic nerve and their branches, to the eighth rib.

The **motor** effects of this lesion are characterized by contracture or relaxation of the muscles supplied by the nerves in relation, and by lessened or increased peristalsis of the viscera supplied by the part of the great splanchnic nerve which is in relation with this rib, viz., the liver, bile ducts, stomach, and small intestine, upper part. The diaphragm is affected, this interfering with respiration and the return of the blood from parts below the muscle.

The **vaso-motor** effects are manifest by dilatation or constriction of the vessels of the muscles of the back, the thoracic wall, pleura, cord, stomach, liver, pancreas, and duodenum. The vaso-motor impulses to these parts pass over the splanchnic, recurrent meningeal, and eighth thoracic nerves and they are in relation with the eighth rib.

The **secretory** effects are localized sweating along the eighth interspace and altered secretion in the viscera supplied with secretory im-

pulses by the great splanchnic nerve, viz., the liver, pancreas and stomach. The principal effects of a subluxation of this rib are, pain along the course of the rib, pleurisy, shallow and painful respiration, and liver disturbances such as biliary colic.

*McConnell states in experiments on dogs in which the ribs were displaced: "Three weeks after the production of the lesions, dissection showed the eighth rib on the right side and the seventh rib on the left displaced upward as the vertebral ends.

The muscles, superficial and deep, contiguous to the lesions, were rigid.

There was marked inflammation of the corresponding sympathetics and rami (macroscopically and microscopically).

Enlargement of the spleen to twice normal size."

THE NINTH RIB.

The **ninth rib** furnishes a landmark for the location of the gall-bladder and the spleen. The upper edge of the spleen is in relation with the left ninth rib, while the costal cartilage of the right ninth rib is in relation with the gall-bladder. The **costal cartilage** of the rib is often **injured** by falls on the side, and sometimes by injudicious treatment. Its **lesions** are similar in character to lesions of the ribs above and the effects are about the same as those of the eighth rib. A lesion of this rib will affect the innervation of the small intestine, liver, spleen, pleura, gall-bladder, a portion of the peritoneum and the muscles in relation, especially the diaphragm. These effects occur because of the relation of the rib to the nerves mentioned, on account of which the displaced rib exerts pressure directly on one or more of them.

The disorders associated with this lesion are biliary colic, congestion of the liver, affections of the small intestines, intercostal neuralgia, girdle pain, herpes zoster, pleurisy and other respiratory disorders caused by effects on the diaphragm.

This rib is subject to **downward displacements** on account of the attachment of muscles, such as the serratus posticus inferior and diaphragm, and on account of the obliquity of the rib and the shape of the articular facets. The facets on the transverse processes of the lower thoracic vertebræ face slightly downward, while those of the vertebræ above face slightly upward. This is, in the case of the upper ribs, for

*Journal A. O. A., Vol. V, p. 14.

the better support of the chest as in the carrying of weights, while in the case of the lower ribs, it gives greater freedom to the movements of the diaphragm. Perhaps this accounts for the frequency of prolapsus or downward displacement of the lower ribs.

It is claimed that pressure applied to the vertebral end of the right ninth rib will relieve hepatic colic. This is explained by the fact that the afferent impulses from the gall-bladder and bile ducts pass over that portion of the great splanchnic and gangliated cord, that are in relation with the head of the right ninth rib and most if not all, the impulses to and from the liver and gall-bladder pass over the right side. Perhaps a better explanation is that the inhibition lessens the number and intensity of the motor impulses hence dilatation of the duct follows.

THE TENTH RIB.

The **tenth rib** is classed with the peculiar ribs because it has a single facet for articulation with the body of the tenth thoracic vertebra. It is long, curved and has the usual groove, tuberosity, and angle. The distance between the angle and the tuberosity is greater than in the ribs above, also the obliquity is greater.

The **mobility** is greater than that of the ribs above, and it is more subject to displacement from contraction of the muscles attached to it.

It is in relation with the spleen, liver, and suprarenal capsule; the pleura and diaphragm; and the lesser splanchnic and tenth thoracic nerves and their branches and connections.

The lesions of this rib cause disturbances of function in a way similar to those of other ribs, that is, by direct pressure on structures or indirectly, through effects on nerves and the spinal cord. The costal cartilage of this rib is often broken off but causes little trouble, other than a local weakening of the part.

Pain in the abdominal wall **near the umbilicus** is one of the most common of effects of a lesion of this rib. It is explained by the fact that the tenth intercostal nerve is in relation with the rib and is impinged on by the subluxated rib. The pain is usually referred to the periphery of the nerve, hence the pain is felt at the umbilicus. This pain may be one referred from disease of the small intestine as in intestinal indigestion, or from kidney disorders as in acute inflammation.

A relaxed abdominal wall is due, in many cases, to a dropping of the lower ribs, and the tenth, takes part is the general descent. In some

cases the lesions of the ninth and tenth ribs seem to be the primary causes. In anemia, this rib is usually displaced downward but it may be an effect instead of a cause. In irritative lesions of this rib, the abdominal wall is tender and contractured. This is explained by the stimulation of the tenth intercostal nerve. The abdominal muscles in relation with this rib, connect with their spinal center, by way of the tenth intercostal nerve. If this connection is broken, relaxation of the muscles takes place, but if the nerve or its communicating branches are stimulated, contraction or contracture of the abdominal muscles is the result. The nerve connections existing between the spinal cord and small intestine are often interfered with by this lesion, and some disorder of these parts is the result. This is also true of the kidney, and ovary and consequently any disease of these parts may be the result of a lesion of this rib. Respiration is affected through the disturbance of the diaphragm, this muscle being attached to the rib.

The principal **diseases caused** or predisposed to, by this lesion are Bright's disease, intestinal indigestion, ovarian colic and in fact any disorder of the ovary. The most common effect in recent cases is pain in the abdomen at or near the umbilicus, which is often mistaken for peritonitis, appendicitis, ovaritis or some disease of the intestines.

THE ELEVENTH RIB.

The **eleventh rib** is peculiar in several respects. It has a single facet for articulation with the body of the eleventh thoracic vertebra, a poorly developed angle, no tubercle and no neck. It does not articulate with the transverse process of the vertebra, is short, twisted but little, and the anterior end is pointed. The subcostal groove is shallow and the end of the rib is tipped with cartilage which is pointed and occasionally broken off by trauma or by injudicious treatment as in the ninth and tenth ribs.

On account of the marked mobility of this rib, it is called a **floating rib.** This free mobility is due to the fact that the sternal end is free, while the vertebral end has only a single articulation. The **position** of this rib is then controlled to a great extent, by the **condition of the muscles** and **other tissues attached to it.** This ought to be taken into consideration when we attempt to reduce a dislocation of it since it will do little if any good to correct the subluxation unless the muscles attached to it are restored to a normal condition.

This rib acts as a stay or support for the muscles attached to it as

do the ribs of an umbrella. It is fixed by the muscles attached below and thus furnishes a fulcrum for the action of the respiratory muscles and especially the diaphragm. These muscles are the external oblique, transversalis, serratus posticus inferior, accessorius, ilio-costalis, levator costæ, and the intercostals. The pleura, parietal layer, lines the inner aspect of the rib. The left one is in relation with the spleen while on the right side the liver is in relation. The upper part of the kidney is sometimes in relation with the rib.

The **lesions** of this rib are usually of **two kinds,** the one in which the **anterior end is turned downward,** thereby increasing the eleventh intercostal space, the other in which the rib is rotated forward and upward and the point carried up under the tenth rib. In this case the rib seems to be forced directly inward as well as rotated. The first is diagnosed by finding the lower edge of the rib prominent, the point turned downward and outward, the intercostal space widened at the anterior end and lessened at the vertebral end and by finding tenderness along the vertebral end of the rib. The position as it is determined by palpation, is typical in the second case. The point of the rib is felt with difficulty if at all.

The **effects** of a lesion of this rib vary with the degree, the way in which it occurred, the length of standing and the condition of the tissues attached to it. The pleura and muscles are affected since they are attached to the rib. The **spleen** and **liver** are affected because they are in close relation. If the rib is dislocated inward as is often the case from improperly worn clothes, it presses directly on these viscera. I have made dissections in which I found **grooves in the liver** caused by tight lacing, by which the ribs were forced into the substance of the liver.

The **intercostal vessels** in relation, will in some way be affected by the lesion, and as a result, the circulation of that part of the spinal cord will be disturbed. These blood-vessels are in relation with the head of the rib and when a subluxation occurs, pressure is exerted directly on the vessels.

The **nerves** in relation that would in ordinary cases be affected by a displacement of the rib, are the eleventh thoracic with its anterior and posterior divisions, the sympathetic cord and the eleventh ganglion and its branches which connect it with the cerebro-spinal nerves in relation, and the nervi efferentes of this ganglion.

Pseudo-appendicitis is one of the most common of results of a lesion

of this rib. The patient describes a pain that is in the right iliac fossa, which is similar to if not identical with that of true appendicitis, of the chronic form. There is tenderness on pressure, on extension of the body, and usually some indications of bowel disorder. These symptoms result from the lesion irritating or otherwise affecting the eleventh intercostal nerve, which is distributed to the iliac fossa. The point of greatest pain is at McBurney's point, that is midway between the umbilicus and the anterior superior spine of the ilium. In true appendicitis, the pain is referred over this same nerve hence the error in diagnosis. The nerve also supplies the muscles of the abdominal wall in relation, hence when it is irritated as it is in most cases of subluxation, the muscles contract, become tender and the patient with difficulty can extend the limbs or bend the body backward.

In many cases of supposed **ovarian disease,** the eleventh rib is subluxated and presses on the eleventh intercostal nerve, which produces pain in the same area as is found in organic disease of the ovary. In true ovarian disease, the pain is referred to the areas innervated by the eleventh intercostal, since this segment of the spinal cord supplies the ovary. Head's law very nicely explains these referred pains and especially those from ovarian and bowel disorders. A "stitch" in the side is so often caused by a lesion of this rib. On account of its free mobility, extreme lateral flexion of the body or sudden twists will often cause the rib to be pulled from its normal position by muscular action. This produces an irritation of the nerve so that any movement of the part produces a pain of such a character that it is familiarly called a "catch."

Kidney, ovarian and **bowel disorders** often result from a lesion of the eleventh rib since the connection existing between the spinal cord and these organs is interfered with by the lesion. The explanation is that this connection is by way of the lesser splanchnic nerves, the white rami and the gangliated cord. These nerves are in relation with the head of the eleventh rib and will beyond doubt, be impinged on by a subluxation of the rib; or the blood-vessels going to and from the spinal cord through the eleventh intervertebral foramen will be pressed on and thus the nutrition of the cells located in this segment which give rise to the impulses passing out over the above named nerves will be interfered with. Clinically, it is a demonstrated fact that a lesion of this rib will produce disease of the kidney, ovary and bowel.

The **condition of the abdominal muscles** is, to a certain extent, con-

trolled by the condition of this rib. The explanation is that the motor and trophic impulses to these muscles pass out over the eleventh intercostal nerve and it is in relation with this rib and would be affected by a lesion of it. The lesion may be an irritative one and contracture would be the result or it may be a paralytic one, in which case relaxation would be the sequel. In other cases, the effects are the result of traction or pressure on these muscles since most of them are attached to this rib. I will mention the diaphragm as a special example. Its position and function are always more or less disturbed by a lesion of the eleventh rib. As a result, the openings in it are lessened in size this in turn causing congestion of parts below and a greater strain is thrown on the heart. Dr. Still has often mentioned this fact in connection with heart disturbances such as palpitation, arrhythmia and even regurgitation and hypertrophy.

Hiccough is the best example of disturbance of function of the diaphragm as a result of a rib lesion. The traction on or irritation of, this muscle, causes it to contract spasmodically ,which condition is called hiccough. This is especially true of the worst types of this disease which ofttimes proves fatal.

THE TWELFTH RIB.

The **twelfth rib** has a single facet for articulation with the pedicle of the twefth thoracic vertebra. The rib is but little twisted, short, pointed at the anterior extremity, and the shaft is narrow, rounded and smooth above, and rough and sharp on its inferior aspect. It has no angle, neck, tubercle, nor subcostal groove. It has a greater range of movement than any of the ribs and is in reality,a floating rib. Like the eleventh rib, its position is determined by the condition of the tissues attached to it. It acts as a stay and support of the sides of the abdominal parietes. As in the case of the eleventh rib, it, when fixed by contraction of the muscles below, acts as a fulcrum for the respiratory muscles. It is fixed from below by the quadratus lumborum muscle, some of the abdominal muscles and the ligamentum arcuatum externum.

This rib is in relation with the kidney and usually the large bowel. The attachment of muscles is the same as for the eleventh rib except that the quadratus lumborum is only attached to the twelfth. In addition, it gives attachment to some of the ligaments of the diaphragm.

The rib is subject to displacements similar in character to those of

the eleventh, that is the anterior end may be forced downward, or up under the eleventh rib. The normal obliquity is less than that of the rib above, yet it is often found in such a state of descent, that it almost or actually touches the crest of the ilium. This is the result of a general weakening of the abdominal walls. The rib may be pulled down by the contraction of the quadratus lumborum muscle which is attached to the lower border of the rib.

On account of its position, it is subject to displacement from the wearing of improperly fitted clothing and especially from the wearing of belts or tight bands. Other lesions result from muscular contraction, and forced lateral flexion or extension of the body. These lesions produce disease by pressure on adjacent tissues, traction on muscles and ligaments attached, pressure on viscera in relation and by pressure on the nerves and blood-vessels in the twelfth thoracic intervertebral foramen.

The **motor** effects are characterized by contracture or relaxation of the abdominal muscles, and by increased or decreased activity of the ureters, tubes and intestines. The muscular effects are explained by the fact that the nerve supply of the abdominal wall comes in part from the twelfth thoracic, and this nerve is either stimulated or inhibited by a lesion of this rib, because it is in relation. If stimulated, there will be contracture of the lower abdominal muscles but if the subluxation inhibits the passing of motor impulses along the nerve, there will be a relaxation of these muscles. In many cases, the contractured or relaxed condition of these muscles is due to other causes and the rib lesion is secondary. The principal **sensory** effect is pain in the iliac fossa. Pain or some sensory disturbance is referred to the back, crest of the ilium, and over the hip as low as the great trochanter, that is, in the areas supplied by the twelfth intercostal nerve. Visceral pain and sensory disturbances of the peritoneum sometimes result from this lesion on account of the relation of the rami communicantes to the head of the rib. Usually the pain is referred to the cerebro-spinal nerves in relation, instead of the sympathetic. On this account, irritation of visceral nerves having their course in the twelfth thoracic segment, either peripherally or along their course as at the head of the rib, will result in the pain being referred to the cerebro-spinal nerves in relation, that is the twelfth thoracic. This explains the fact that in most cases of ovarian, kidney and intestinal disorders, the pain or ache is felt in the back or along the course and distribution of the twelfth thoracic. The **secretory** and **vaso-motor** disorders

resulting from this lesion, are explained through the above mentioned nerves, that is the rami, lesser and least splanchnics and the sympathetic ganglia, since these nerves carry vaso-motor and secretory impulses to the above mentioned organs. Disorders of the integument of the lower part of the back are sometimes the result of a lesion of this rib, since the nerves carrying trophic, vaso-motor, sensory and secretory impulses, are in relation with the rib and are involved in many cases. A localized eruption as in herpes zoster and excessive secretion of sweat in this region, are the most common of these disturbances.

THE THORAX.

The **thorax** is formed by the ribs, the sternum and costal cartilages in front, the shafts of the ribs on the side, the bodies of the thoracic or dorsal vertebræ and their discs behind. In **shape** it resembles a truncated cone, flattened antero-posteriorly, and rounded laterally. These structures are so arranged that they form a movable frame work to which are attached the muscles of respiration and which protects the heart and lungs.

The **sternum,** which is composed, in the adult, of three flat spongy bones, is of interest to us in that the lower end, the ziphoid appendix, is often depressed as in certain occupations in which the patient assumes a stooping posture, or in certain diseased conditions of the bones, as rickets. The costal cartilages connect the sternum with the true ribs. They vary in length and obliquity. The upper cartilages are short, the lower large and oblique. The **right side** of the chest is usually **larger** than the left, possibly on account of the fact that most people are right handed. According to Holden, the **diameters** of the chest at different levels in the average male skeleton are as follows: "The antero-posterior diameter, at the inlet, is two and one-fourth inches; at the junction of the manubrium and gladiolus, four and one-half inches; and at the outlet, five and three-eighths inches. The transverse diameter at the inlet measures four and three-eighths inches, between the second ribs, seven inches; between the third ribs, eight and one-eighth inches; gradually increasing between the succeeding ribs, it attains its maximum between the ninth ribs, where it measures ten and five-eighths inches; and gradually diminishes below that level." The **vertical diameter** in increased in inspiration.

The **female thorax** differs from the male in that its capacity is smaller, the sternum shorter, and the lower opening smaller in proportion than

is that in the male. The mobility of the upper part is greater. This is possibly due to the compression of the lower ribs from the wearing of certain kinds of clothing. The ribs are smaller and more oblique. The free mobility of the upper ribs permits of greater enlargement of the thoracic cavity in adaptation to the requirements of pregnancy. If this

FIG. 125.—Showing a subluxation of the eighth rib on the left side. U. upward displacement at the vertebral end; A. widening of the interspace below; D. downward displacement at anterior end; B. widening of the ninth interspace in the mid-axillary line. Compare the interspaces on the two sides. (From photo of dissection made at the A. S. O.).

were not true, pregnancy would interfere to a considerable extent, with respiration on account of the pressure on the diaphragm.

In most cases it is easy to locate or count the ribs, but in obese people, the landmarks are obliterated and on this account we quote Holden's rule for counting the ribs:*

"(a) The finger passed down from the top of the sternum soon comes to a transverse projection, slight, but always to be felt, at the junction of the first with the second bone of the sternum. This corresponds with the middle of the cartilage of the second rib.

(b) The nipple of the male is placed, in a great majority of cases, between the fourth and fifth ribs, about three quarters of an inch external to their cartilages.

(c) The lower external border of the pectoralis major, corresponds with the direction of the fifth rib.

(d) A line drawn horizontally from the nipple round the chest cuts the sixth intercostal space mid-way between the sternum and the spine. This is a useful rule in tapping the chest.

(e) When the arm is raised, the highest visible digitation of the serratus magnus corresponds with the sixth rib. The digitations below this correspond respectively with the seventh and eighth ribs.

(f) The scapula lies on the ribs from the second to the seventh, inclusive.

(g) The eleventh and twelfth ribs can be felt even in corpulent persons, outside the erector spinæ, sloping downward.

(h) One should remember the fact that the sternal end of each rib lies on a lower level than its corresponding vertebra. For instance, a line drawn horizontally backward from the middle of the third costal cartilage at its junction with the sternum, to the spine, would touch the body, not of the third dorsal vertebra, but of the sixth. Again, the end of the sternum would be about the level of the tenth dorsal vertebra. Much latitude must be allowed here for a variation in the length of the sternum, especially in women."

Movements of the Ribs.

In inspiration, all the diameters of the chest are increased, which is accomplished by the action of certain muscles which draw the anterior ends of the ribs up, and on account of the shape of the ribs, this increases

*Landmarks Med. and Surg. Holden, p. 22.

FIG. 126.—The right side of the thorax. The lines denote the position of the right lung.

both the antero-posterior and lateral diameters of the chest. The lower ribs are drawn downward and the upper ones are fixed by the scaleni muscles, therefore the vertical diameter is possibly increased. The **muscles of inspiration** are the diaphragm, by the contraction of which, the vertical diameter is increased, the scaleni, levatores costarum, serratus posticus superior and the external intercostals. The movements of the chest are hampered by abnormal conditions of these muscles or displacements of the ribs. The movements should be **symmetrical,** quite **free** and **without pain.** In cases of lung disease, the movement is found unilateral, decidedly lessened and painful, particularly in cases of pleurisy and adhesions.

The **surface markings** of the chest are of importance to the practitioner, since there are so many changes of contour from diseases of the lungs or heart or the great blood-vessels, which can be diagnosed by noting their relation to certain of the landmarks of the thorax.

The **heart** is placed obliquely in the chest cavity, with its base at the junction of the second costal cartilage with the sternum and its apex at the junction of the fifth rib with its costal cartilage. To locate its base, draw a transverse line across the sternum a little above the level of the third costal cartilage. The base extends to about one-half inch to the right of the sternum and one inch to the left. The apex is, in the normal heart, located at a point about two inches below the left nipple and one inch toward the medium line. This corresponds to the fifth interspace. Holden says a neeedle introduced in the third, fourth or fifth right intercostal space close to the sternum, would penetrate the lung and the right auricle. A needle passed through the second intercostal space close to the right side of the sternum would, after passing through the lung, enter the pericardium and the most prominent part of the bulge of the aorta. To locate the pericardial region in which there is **cardiac dullness,** according to Latham, make a circle of two inches in diameter around a point mid-way between the nipple and the end of the sternum. This region will indicate sufficiently for all practical purposes, that part of the heart which lies immediately behind the wall of the chest and is not covered by lung nor pleura. The **aortic valves** are behind the third intercostal space on the left side. The **pulmonary valves** are behind the junction of the third costal cartilage and the sternum on the left side. The **tricuspid valves** are right behind the sternum at about the level of the fourth costal cartilage. The **mitral valves** are behind the third intercostal

space just to the left of the sternum. Therefore, in organic heart disease, the murmur is heard over these spaces, the location depending on the valve affected.

The upper border of the **pericardium** corresponds to the junction of the first and second portions of the sternum, that is, the sternal end of the second rib. It is somewhat elliptical in shape and extends to the right as far as the para-sternal line, to the left, to the mid-clavicular line and downward to the diaphragm, with which it is united. It is attached to the sternum in front and the fifth costal cartilage on the left side. In effusions the operation called paracentesis is performed through the fifth or sixth interspace of the left side, this depending upon the degree of distension.

The **pleura** extends upward to a line drawn from each sterno-clavicular joint to the prominence at the junction of the first and second parts of the sternum. Eisendrath says: "The two pleuræ run parallel to each other, the right passing a little beyond the median line. The space between them corresponds to the location of the anterior mediastinum. At the fourth rib, the left pleura leaves the sternum and passes outward in an oblique manner, following the left border of the sternum to the sixth cartilage. The space thus left between it and the sternum, corresponds to that portion of the pericardium which is in contact with the chest wall. On the right side the pleura continues almost to the ensiform process, and then passes gradually outward, crossing the lower border of the seventh rib in the mammary line, the ninth rib in the axillary line, and the eleventh near the spine."

The highest point of the pleura is about one and one-half inches above the clavicle, which corresponds to the apex of the lung. The lowest point is the twelfth rib. It extends almost to the tip of this rib.

The surface markings of the **lungs** are almost identical with those of the pleuræ except that they do not extend so low. The only difference is that the lower portions of both lungs are at the sixth rib in the mammary line, the eighth rib in the axillary and the tenth rib behind. During inspiration the lower border of the lung moves downward through the space of one rib. The position of the lungs as well as their condition is determined by percussion, which is best done with the patient in the sitting or erect posture.

The arch of the **aorta** corresponds to a line drawn from the junction of the costal cartilage of the left side and the sternum, to the upper border of the second rib on the right side.

The **trachea** and **bronchi** are in the median line and correspond to a line drawn from the upper margin of the sternum to the level of the second rib. Bifurcation takes place at the second rib.

The surface markings of the attachments of the **diaphragm** correspond to a line drawn around the body passing through the ensiform cartilage and bony ends of the sixth ribs to the body of the first lumbar vertebra. During the contraction of the diaphragm, the position of the ribs is changed. In cases in which the ribs are softened, the diaphragm, by its contraction, often produces a groove, called Harrison's groove. This is the result of rickets or attacks of asthma or other obstructive respiratory disorders.

The **spleen** corresponds to the ninth, tenth and eleventh ribs and is slightly anterior to the axillary line. In enlargements of this organ it is displaced forward and downward and produces a marked change in contour of the left side.

The **kidneys** are in relation with the twelfth rib,hence have little to do with the contour of the chest, although in enlargements of the organ, a fullness at the vertebral end under the twelfth rib, is found.

The **stomach** lies almost entirely on the left side under the true ribs, but is often prolapsed on account of relaxation or distension. In distension, it is displaced downward and to the right. It extends slightly across the median line of the body.

The **nerves of the chest wall** are the intercostal, which are in relation with the under surface of the ribs. At the points at which the perforating branches emerge, that is, at the angle of the rib and the axillary and parasternal lines, there is marked tenderness in cases of displacements of the ribs, pleurisy and intercostal neuralgia.

The **arteries** are the intercostal, which are derived from the thoracic aorta. The **veins** of the chest wall correspond to the arteries and most of them empty into the azygi. The **lymphatics** of the upper part empty into the axillary glands. The deep lymphatic vessels of the chest wall are the intercostal and diaphragmatic, which eventually empty into the internal mammary lymphatic glands. The superficial, as stated above, empty into the axillary glands, therefore diseases of the breasts will produce enlargements of the axillary glands, as in cancer. The superficial glands of the chest wall are the pectoral and the epigastric. The pectoral drain some of the lymphatic vessels of the mammary gland. The deep lymphatic glands of the chest wall are the intercostal (exter-

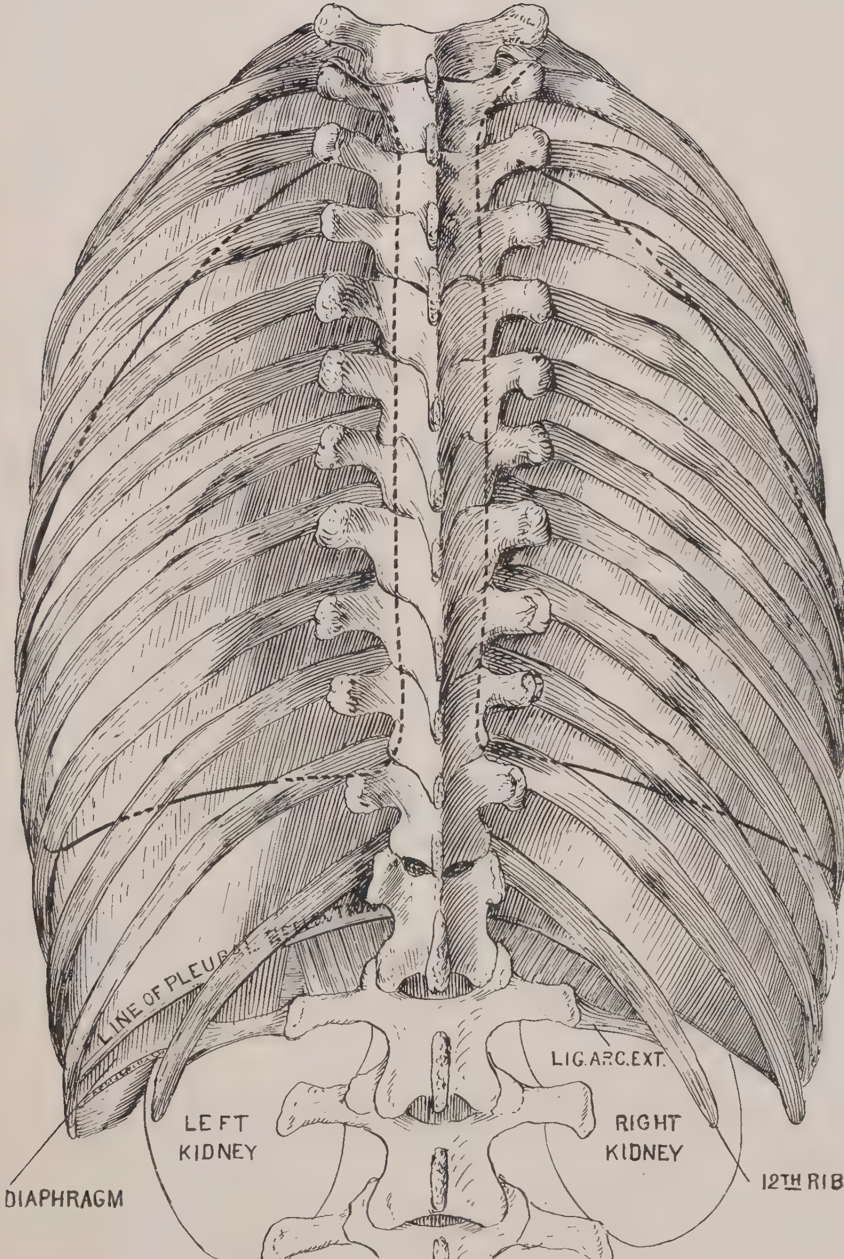

Fig. 127.—Posterior view of the thorax. (After Cunningham). Note the relation of the kidneys to the twelfth rib and the pleura.

nal, anterior and posterior) and internal mammary. The posterior intercostal glands are of interest to us in that they **lie opposite the heads** of the ribs and therefore would be affected by rib lesions. They drain a part of the intercostal spaces, the spinal canal, the muscles of the back and the diaphragm.

The **contour** of the chest is determined more by the size and condition of the viscera, that is, the heart and lungs, than by any other thing. It is conical in form, the broader part of the cone being the upper part. The walls are convex but this varies considerably in different patients on account of the difference in muscular development, the amount of fat deposited and the condition of the bony parts. Change of contour results from change in size of the viscera, from certain occupations, diseases of the air passages, abnormalities or diseases of the spinal column, and the general condition of the patient.

In **spinal diseases,** the contour of the chest is usually changed. In diseases in which the mineral matter of the bone is decreased, as in **rickets,** the contour of the chest is also altered. These changes of contour are of vast importance to the physician, because they are indicative, if not diagnostic of the condition of the vital organs and particularly the heart and lungs. If the chest is **flat,** that is if the antero-posterior diameter is lessened and the lateral diameter apparently increased, the ribs more oblique, the sternum depressed, we call it a **tubercular chest.** These seem to be hereditary cases, especially those predisposed to pulmonary tuberculosis, although it does not necessarily follow that tuberculosis is present in a person who has a flat chest. In such cases the ribs are very flexible, expansion is lessened and the pectoral and other muscles are not well developed. This can be remedied partly by deep breathing exercises on the part of the patient to develop the lungs, and partly by the correction of lesions which interfere with the innervation of the muscles which hold the ribs in normal position. This muscular atrophy or non-development, may be partly the result of non-use of the muscles, or the result of rib or thoracic lesions which interfere with the trophic nerves to them. By advising the patient to take exercise, these muscles will be developed because of the increased rate of inspiration. The respiratory muscles lift and thereby produce a pressure vacuum in the thoracic cavity and the air rushes in to fill this. Therefore, if the patient does not exercise, these muscles are not used and do not develop, and even atrophy, if they have once been developed.

The **barrel-shaped** chest is short and round, that is, its antero-posterior diameter is nearly as long as its transverse and is indicative of emphysema. In such cases the ribs are almost horizontal and the interspaces increased, and respiration is carried on almost entirely by the

Fig. 128.—Showing the deltoid and pectoralis major muscles. The movements of the arm are dependent to a great extent on the normal activity of these muscles.

diaphragm. The chest wall moves but little during respiration and the ribs seem to have become fixed in this abnormal position.

The chest is found to be deformed in **rickets,** there being a beady condition along the junction of the ribs with their costal cartilages and immediately below this there is a groove, called Harrison's groove. If asthma occurs in such a case, the deformity called "Pigeon" or "funnel breast," may result. In Pigeon breast, the sternum and costal cartilages project beyond the ends of the ribs. The transverse diameter is shortened while the antero-posterior diameter is lengthened. The beaded condition to which has been applied the term "rachitic rosary," is due to the thickening of tissues at the junction of the ribs with their cartilages. Deaver quotes Treves saying, that the explanation of this deformity is: "When an inspiration is taken, a threatened vacuum is created within the chest, air rushes in by atmospheric pressure, and at the end of the inspiration the balance of pressure without the chest and within it are equalized. If in inspiration there is an impairment to the entrance of air, the atmospheric pressure upon the external wall of the chest must produce some effect, being unbalanced by a light pressure upon the inner chest wall. In children, and especially in rickety children, the thorax is very pliable and elastic, and if a constant impediment exists to the entrance of air, as afforded, for example, by greatly enlarged tonsils, the thoracic walls may yield in time to the unbalanced pressure brought to bear upon them at each inspiration. The weakest part of the thorax is along the costo-chondral line on either side, and it is here that the parieties yield most conspicuously in such cases, and by this yielding the deformity is produced."

The **funnel breast** is characterized by a deep depression at the lower part of the sternum. It is believed to be the result of obstructed breathing as in hypertrophied tonsils, and adenoid growths in the throat. These obstructions interfere with respiration so that during inspiration the lower part of the sternum is forcibly retracted. The patient often assumes a bent posture, the ribs are soft and the development of the lungs seems to be interfered with. Sometimes it attacks only one side and in some of the author's cases a depression was found as wide and deep as the hand, which corresponded with the sixth and seventh ribs.

Scoliosis produces a unilateral enlargement of the chest. This is the result of rotation of the vertebræ which invariably complicates a case of lateral curvature. The ribs are carried with the transverse pro-

cesses so that in a right lateral curvature the left side of the chest would be prominent and the left side would be depressed. The contour of the chest will be changed in **kyphosis,** it becoming more nearly round, that is, barrel-shaped. In **lordosis** the antero-posterior diameter of the chest is lessened and this is one of the most common of conditions in which

FIG. 129.—Showing an extreme case of progressive muscular atrophy, resulting from injury by fall from bicycle. The lesions were at the second and third thoracic articulations. Death resulted from pneumonia. There was little thoracic respiration. (From photo).

the chest and spine are affected. It seems to be a general rule that in posterior deviations, the antero-posterior diameter of the thorax is increased and the obliquity of the ribs lessened, while in anterior conditions the opposite effects occur.

Unilateral enlargement is due to **cardiac hypertrophy.** This can be determined by locating the heart by percussion and noting the location of the enlargement. A shrinking of one lung has the effect of making the opposite side appear to be enlarged. In old **pleural adhesions**, the chest is flattened and movements are lessened in the affected area. On account of this, the opposite side is developed to such an extent that there is really enlargement. In collapse of one lung due to destruction of tissue as in tuberculosis, the chest wall becomes depressed over that area and the opposite side becomes enlarged. Unilateral enlargements may also be due to hypertrophy of the **spleen,** or if on the lower right ride, to hypertrophy of the liver. The **usual cause of slight unilateral enlargement is scoliosis.** A displacement of two or more ribs may also cause a slight change in contour on the affected side.

It is important to be able to ascertain the cause of a change of contour as well as the degree of enlargement. To do this accurately, inspection as well as palpation should be made. In some cases there is bi-lateral shrinking of the chest due to diseases of the lungs, principally old adhesions. By causing the patient to take a deep inspiration, the degree of movement can be ascertained and by this to a certain extent the extent of the adhesion.

In certain **occupations** the contour of the chest may be changed as in miners, shoe-makers or those whose occupation requires a stooping or bent posture. This is accompanied by a posterior condition of the thoracic spine and is usually not pathological.

In the weak and anemic, the ribs often **get down,** sometimes as the cause of the condition, but more commonly as the result. The ribs are held in normal position by the tonicity and contraction of the thoracic muscles and if these muscles are not well nourished and if there are lesions which interfere with their innervation or nutrition, relaxation results and the ribs become more oblique and closer together. In such cases the lower edges of the rib evert, so that in extreme cases they even overlap. This obliquity may be due to tight lacing. All the diameters of the lower part of the chest are decreased and the ribs are often forced as low as the crest of the ilium and the ilio-costal space is almost obliterated, the great muscles of the back are atrophied and the movements of the body impaired. The viscera in relation are compressed and the writer has seen cadavers in which the liver was furrowed by the ribs in relation having been forced into it.

The **muscles** which have to do with the contour of the thorax are the pectoral, intercostal, serratus magnus and the muscles of the back. The muscles on the front and side of the thorax all stand out prominently in the normal case, but in so many diseases they are atrophied. Deep breathing is to be advocated, partly on account of the development of the lung which follows, and partly on account of the development of the

FIG. 130.—Showing the change in contour of the chest in a marked case of angular curvature (Pott's disease).

muscles of the thorax. The contour of the thorax is partly governed by these muscles, therefore in cases in which they are atrophied, the contour is abnormal.

The contour of the chest may be changed by **pleural** or **pericardial effusions.** Ordinarily, the interspaces are only enlarged and appear puffed, but in some, there is marked swelling of the wall. The character and location of the swelling with the presence of disease of the heart or lung, and the tenderness elicted on pressure over the area, make the diagnosis of the cause of the change of contour fairly easy.

The general **contour differs very materially in different people.** In some the character of the clothing, occupation and the degree of muscular development so change the contour that there is a wide deviation from the normal. The effects are measured by the amount of pressure exerted on the viscera and the changes in the individual ribs which affect the gangliated cord and other important structures in relation with the head of the rib. If the changes come on very slowly, the viscera may become adapted to their changed relations as rapidly as the changes occur, while in most cases of deformity of the thorax, it is the result not the cause of the visceral disease.

Tenderness of the chest is suggestive of a diseased condition of the lung, heart or pleura or of a subluxated rib. In pneumonia, the tissues over the diseased area, become thickened and tender. In chronic disease of the lung there is tenderness on pressure over the interspaces. Such tenderness is, in all probability, due either directly to the rib lesions that are the primary cause of the disorder, or to the changes in the spinal cord which are the result of the disease; these affecting the intercostal nerves that supply the chest wall. Pleurisy and pericarditis are accompanied by tenderness in the chest wall in relation with the diseased area.

A localized lowering of the surface **temperature,** is suggestive of a lesion of the rib in relation or of disease of the viscus innervated by the segment that supplies the affected part. This is true of chronic diseases and especially of chronic gastritis. Localized sweating has a similar significance. The anatomical explanation lies in the fact that the vitality of the affected part is lowered either by the rib lesion directly or else by the effects of the disease on the spinal cord or the blood-vessels supplying the nerve tissues.

THE ABDOMEN.

The **condition** of the **abdominal wall** is of great importance because it is a fairly reliable sign of the condition of the viscera of the pelvic, as well as of the abdominal cavity. The various abdominal diseases as well as pelvic disturbances are depicted in the abdominal wall. It may be an enlargement or simply a tenderness. The abdominal wall extends from the costal arches to the crests of the ilia. It is **elastic,** changes its form readily and adapts itself to changes without injury to itself. A blow, such as a kick or a fall upon some sharp object will often cause no injury to the wall, but will produce a serious laceration of the abdominal contents. It is composed of integument, fascia, fat, muscles, peritoneum and fibrous tissue.

The **contour** of the abdomen, that is, its prominences and depressions, is governed by the size of the viscera, the amount of fat, or the presence of tumors or visceral enlargements in the abdominal cavity. The accumulation of fat in this place is very marked and McClellan cites a case in which it was four and one-half inches thick.

The **enlargements** of the abdomen are due to many things. **Ascites** produces a symmetrical enlargement, which is diagnosed by a change of contour with change of position, coupled with this, is usually a history of liver disorder. On percussion or palpation, it is usually easy to determine that the enlargement is due to the presence of fluid. **Pregnancy** produces a change in the contour of the abdomen after the third month. This is determined by the signs and symptoms of pregnancy. The enlargement is at first symmetrical and later on becomes somewhat unilateral. **Pelvic tumors,** if large enough to be forced out of the pelvic cavity, produce a change of contour of the abdomen. The enlargement is not symmetrical, but usually there are irregularities which can be clearly palpated. In enlargement of the **spleen,** the contour of the abdomen is changed. Sometimes the tumor extends past the median line in which case, the abdomen is quite large.

In congestion and **hypertrophy** of the **liver,** there is a unilateral enlargement of the abdomen. The diagnosis as to the cause of the enlargement, is based on the palpation and percussion of the liver, and the location of the enlargement. **Peritonitis** will produce a symmetrical enlargement. The accumulation of gas in the bowels will produce some change in the contour, which is most pronounced in the retention of menses.

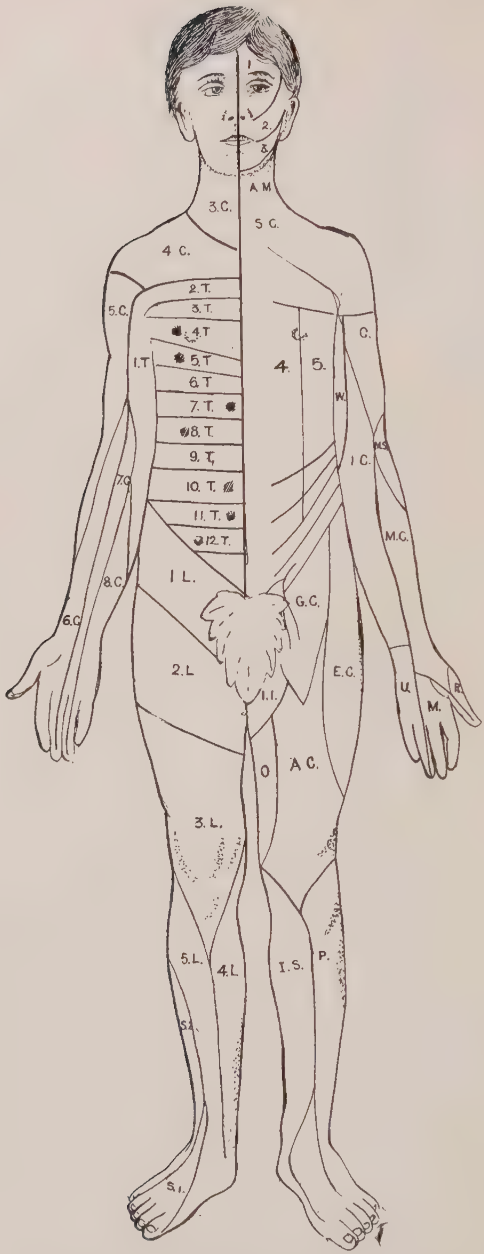

FIG. 131.—Anterior view of the areas of distribution of the sensory nerves of the skin (shown on the left side of the body), and distribution of sensation according to segments of the spinal cord (shown on the right side of the body). (After Eisendrath).

The accumulation of **fat** in the abdominal wall produces a prominence which is often mistaken for tumors. Occasionally a unilateral ventral **hernia** is found, in which case the contour of the abdomen is changed in proportion to the degree of protrusion. Enteroptosis, gastroptosis, abdominal tumors and distension of the urinary bladder from retention of urine are other causes of enlargement of the abdomen.

Retraction of the abdomen is most frequently due to emaciation, or due to constitutional disease, as cancer or to any other disease in which the nutrition of the body is affected. In chronic intestinal indigestion the abdominal wall is shrunken and the patient assumes a stooping posture. In such cases the abdominal wall is contracted and the patient assumes this position on this account, it being the position in which there is the greatest rest to these muscles. In injury of the knee or elbow we have an analogous condition, in which there is a partial flexion of the joint.

There are certain **lines** which are fairly constant. In the female the **lineæ striæ** are present as the result of stretching of the abdominal wall from pregnancy. These lines are also found in cases where the walls have been stretched from any other cause, such as ascites or other enlargement. The recti muscles can be seen and the slight transverse depressions between the different parts of these muscles can usually be outlined. These are called the **lineæ transversæ.** In some cases the recti muscles become separated and a vertical groove results which corresponds to the point of separation. The **umbilicus** is a landmark which is used for certain measurements and for locating some of the abdominal viscera. It is on a level with the disc between the third and fourth lumbar vertebra, or in some cases, of the body of the fourth. It is a depressed cicatrix, which varies in depth in different individuals. In the young, it is often everted and in the aged, it is retracted. In pregnancy, accumulation of gas or other enlargements, it is usually everted. In chronic intestinal diseases it is found retracted. Its depth is probably due to the degree of shortening of the urachus, which is attached to the scar. In some cases the scar fails to close properly and an umbilical fistula is formed through which urine passes.

The **anterior superior spines** of the ilia are,in an average sized person, prominent and are used as landmarks for the location of other parts and measurements of the lower limbs. The **substernal angle** furnishes the landmark for the location of the pyloric end of the stomach, which is a

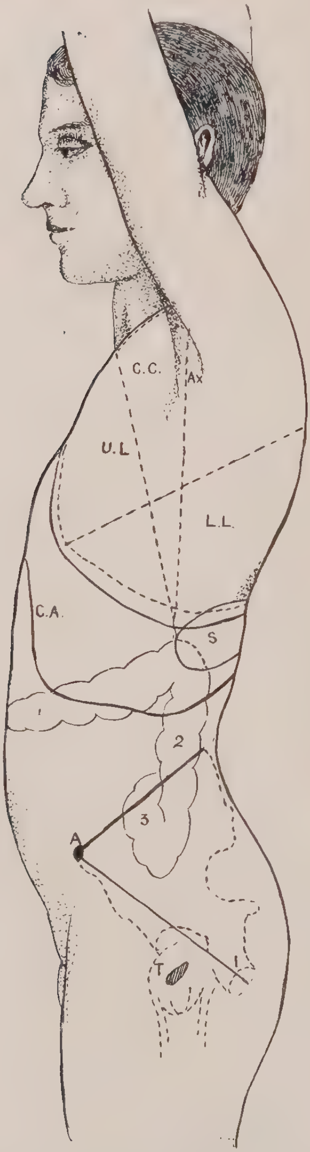

FIG. 132.—Surface markings (on the left side) of the thoracic and abdominal viscera. (After Eisendrath). C. C., costoclavicular line; U. L., upper lobe of lung; L. L., lower lobe of lung; C. A., costal arch; S., spleen; 1, transverse colon; 2, descending colon; 3, sigmoid.; A., anterior superior spine of the ilium; T., trochanter.

few inches directly below. This angle or interchondral space, is formed by the divergence of the cartilages of the false ribs. The depth and width of this angle varies with the shape of the thorax. It is narrow in women who wear tight clothing and in cases of the dropping of the lower ribs or a lessening of the antero-posterior diameter of the thorax from any cause.

The abdomen is arbitrarily divided into **regions** by the passing of vertical lines from the cartilage of the tenth rib and superior spines of the ilia, and transverse lines through the cartilage of the eighth rib and the spines of the pubes. These regions thus formed are called the **right hypochondriac, epigastric, left hypochondriac, right lumbar, umbilical, left lumbar, right inguinal, hypogastric** and the **left inguinal**. It is thus divided for the purpose of describing the position of the viscera and that of the better describing the location of abdominal enlargements or disease of the abdominal viscera.

The **abdominal aorta** corresponds to a line drawn from a point slightly to the left of the ensiform cartilage to another point on a level with and immediately to the left of the umbilicus. In all organic diseases of the stomach and intestines such as gastritis and enteritis, the pulsation of the aorta is markedly increased, sometimes to such an extent that they can be seen. In thin people the artery can be palpated quite distinctly and in the above mentioned diseases, its walls seem to be thickened. The **celiac axis** is given off about five inches above the umbilicus, the renal artery is about four inches above. The **iliac** arteries radiate from the umbilicus downward and outward to a point which is about mid-way between the anterior superior spine of the ilium and the symphysis of the pubis. The internal iliac, is given off at a point about two inches below the umbilicus.

The **liver** lies in the hypochondriac and epigastric regions and sometimes extends across to the left hypochondriac region. Its anterior margin extends about an inch below the costal cartilages and can be palpated in the average case, during respiration. In congestion or hypertrophy of the liver, this margin can be readily palpated. It is tender to the touch and often feels hardened. The upper border of the liver reaches as high as the dome of the diaphragm, the right fourth interspace in the mammary line, the eighth rib in the mid-axillary line and the tenth rib in the scapular line. Posteriorly, it extends to the tenth and eleventh thoracic spine and the bodies of the vertebræ. It extends across the median line about one and one-half inches, and in unusual cases, it reaches

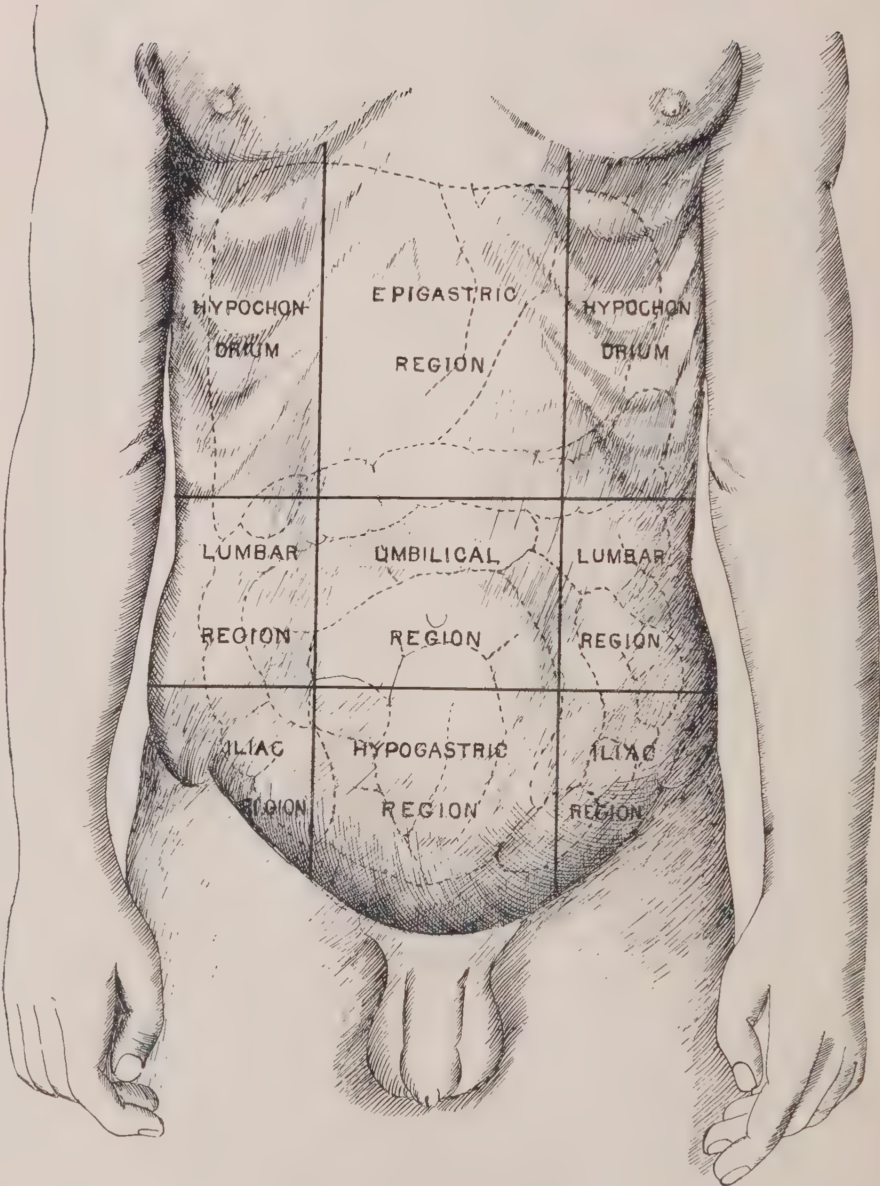

FIG. 133.—The regions of the abdomen.

the left mammary line. Deaver says: "The liver reaches as high as the transverse line drawn through the lower end of the meso-sternum; in the mammary line this transverse line passes over the fifth intercostal space or lower border of the fifth rib. The upper surface of the left lobe of the liver is opposite a transverse line drawn through the lower end of the meso-sternum. The upper surface of the right lobe is opposite the lower border of the fifth rib in the right mammary line; in the right mid-axillary line, opposite the seventh rib; and in the mid-scapular line, opposite the ninth rib; and at the side of the spinal column, opposite the tenth thoracic spinous process." These lines are determined by percussion and are only approximate, since the liver varies greatly in position. The **gall-bladder** is almost entirely covered by the liver, but the fundus projects slightly below the anterior margin and is in relation with the costal cartilage of the ninth rib. The gall-duct passes obliquely downward and empties at a point slightly to the right and above the umbilicus. Clinically, there is often found a thickening of the tissues around the lower end of the duct and the localized hardness can be plainly felt. There is some tenderness in these cases and the condition is almost diagnostic of liver disease.

The **stomach** lies in the left hypochondriac and epigastric regions and its position is more variable than that of the liver. Its cardiac end corresponds to a point over the left costal cartilage of the seventh rib which is about an inch from the sternum. The **pyloric end** lies about an inch to the right of the median line and usually beneath the liver and about three inches from the sterno-xiphoid articulation. Addison says that the pyloric portion of the stomach is practically bisected by a horizontal plane which passes through the abdomen mid-way between the supra-sternal notch and the pubic symphysis. The lesser curvature of the stomach corresponds to a curved line connecting the cardiac and pyloric ends. The greater curvature corresponds to a line drawn upward from the cardiac orifice to the fifth rib and thence to the pyloric orifice. When the stomach is empty it lies quite obliquely in the abdominal cavity and is almost entirely covered by the ribs and cartilages on the left side. When distended, it descends, becomes more nearly transverse and crosses the median line to a distance of two or three inches.

The **small intestines** lie in a frame formed by the large intestine. The **duodenum** is the part which is of most interest to us in that it is quite frequently diseased and because it receives the gall-duct. Eisendrath

says: "The duodenum corresponds on the surface, to the right half of the epigastric region behind the eighth costal cartilage (horizontal portion); the second or vertical portion lies mid-way between the median line of the body and the vertical line which separates the right hypochondriac from the epigastric region. The third or ascending portion passes obliquely upward across the body, from the right half of the umbilical region to the left half of the same, where it joins with the jejunum at a point one inch to the right of the median line (duodeno-jejunal flexure), at a point about mid-way between the ensiform process and the umbilicus."

The **large intestine** is divided into the **cecum, ascending colon, hepatic flexure, transverse colon, splenic flexure, descending colon, sigmoid flexure** and **rectum.**

The **cecum** corresponds to the right iliac and right lumbar region. The base is slightly below McBurney's point. Its position is variable, since it is subject to displacement downward. In constipation and in enteroptosis it often gets into the true pelvic cavity.

The **ascending colon** extends upward to the liver, at which place it makes quite a sharp bend to the median line. The **transverse colon** sags in the middle and reaches almost to the umbilicus. Its position is also variable and it is found almost as often below the umbilicus as above it, especially in cases of intestinal indigestion, constipation and enteroptosis. The writer examined a case in which the transverse colon was found partly in the true pelvic cavity. The **splenic flexure** is in relation with the spleen, at which point it makes a sharp bend forward and downward. The descending colon passes almost vertically downward and when near the pelvic brim makes a turn which is called the sigmoid flexure and crosses the left sacro-iliac synchondrosis. As it passes into the true pelvic cavity, it becomes smaller. The large intestine is accessible to palpation with the possible exception of the hepatic and splenic flexures, and on this account fecal impaction can ordinarily be easily diagnosed.

The **vermiform appendix** corresponds to the middle of the line connecting the umbilicus and the anterior superior spine on the right side. This is called McBurney's point.

The **pancreas** lies immediately below and behind the stomach. It crosses the inferior vena cava, aorta and the body of the first lumbar vertebra. It corresponds to a horizontal line drawn about three inches above the umbilicus.

The **kidneys** are in relation with the eleventh and twelfth thoracic and first and second lumbar vertebræ, and the right is lower than the left. The surface markings on the abdominal wall are as follows: the lowest point extends to the lower border of the tenth costal cartilage, while the upper borders reach to within two inches of a line drawn horizontally through the xiphoid appendix. On account of their depth and the amount of adipose tissue surrounding them, they cannot in the ordinary person be palpated from the front. Deaver says: "a transverse plane through the umbilicus passes just below the lower border of the kidneys, and they are cut in half by a line drawn vertically upward in the middle of Poupart's ligament."

The **external abdominal ring** is in the lower part of the aponeurosis of the external oblique muscle and is in relation with the spine of the pubis. It is of interest in that it consitutes a weak place in the abdominal wall and hernia often takes place at this point. It is called a ring because it gives passage to the spermatic cord, the genital branches of the genito crural nerve and the ilio-inguinal nerve in the male, and in the female the round ligament of the uterus and the above named nerves. In hernia, there is to be found a tumor which increases in size whenever the intra-abdominal pressure is increased, as in coughing and lifting. The opening can ordinarily be palpated and the diagnosis in doubtful cases is based on this. The tests for hernia should be made while the patient is in the erect posture, since the tumor is larger and the impulses more marked with the patient in this position.

The **skin** of the abdominal wall is quite closely adherent to the abdominal fascia, especially around the umbilicus. It is broken in cases of abnormal enlargements as ascites and pregnancy and the lineæ albicantes are thus formed. The deeper layer is continuous with the aponeurosis of the external oblique muscle at Poupart's ligament, the crest of the ilium and the lineæ alba.

The superficial **vessels** are the anterior ends of the lower intercostal and the lumbar arteries and veins. In addition to this are the superficial epigastric, the circumflex iliac, and branches of the internal mammary artery. The superficial **veins** of the front of the abdomen are quite numerous and are subject to varicosities during pregnancy and other enlargements. Deaver quotes Schiff as saying that small veins connect the portal vein with the epigastric veins at the umbilicus. This accounts for the dilatation of them in hypertrophic cirrhosis of the liver.

The **lymphatic vessels** of the abdominal wall accompany the blood-vessels, those above the umbilicus emptying into the axillary glands and those below, into the inguinal. The **nerves** of the abdominal wall are the lower five or six intercostal and branches of the ilio-hypogastric and ilio-inguinal, which are from the anterior division of the first lumbar nerve. The nerve supply to the abdominal wall is of great importance to the physician in that nearly all abdominal and pelvic visceral diseases cause pain to be referred to these nerves. Eisendrath says:* "The spinal segments with which they are connected are also in communication with the viscera of the abdomen and thorax through the sympathetic system. Hence diseased conditions of the abdominal viscera give rise to disturbance in the spinal segments with which they are connected, and the brain, being accustomed to localize pain along the spinal nerves, makes a mistake and refers the pain along the spinal nerve of the segment disturbed. Not only is pain referred, but the skin supplied by the disturbed spinal segments becomes tender, and through a study of these, Head has been able to localize the visceral centers, thus affording the surgeon a means for increased accuracy of location of pain as a symptom in abdominal diagnosis." These nerves supply both the integument and the muscles, therefore a stimulation of them, as in examining the abdomen with cold hands, will cause the muscles to contract and thus make it difficult to palpate the viscera beneath. These nerves are connected with the gangliated cord by means of the rami communicantes. On this account in irritative disease of the viscera as in appendicitis, the abdominal wall becomes tender and rigid. These nerves run obliquely forward and downward, which thing should be remembered in the making of incisions in the abdominal wall.

The condition of the abdominal wall is of importance in that it is a fair indication of the condition of the viscera of the abdominal cavity. Diseases of the abdominal or pelvic viscera are in some way indicated by changes in the abdominal wall or of the structures immediately beneath. A **contractured abdominal wall** is most frequently the result of a chronic peritonitis. In the cases of chronic intestinal indigestion, the wall is quite rigid and the abdomen retracted. It is sometimes suggestive of asthma or other conditions in which the respiration is of the abdominal or diaphragmatic type. If the tightened or contractured condition is accompanied by tenderness, it is probably a case of an intestinal indigestion or chronic peritonitis from other causes. In acute peritonitis,

*Clinical Anatomy, Eisendrath, p. 220.

and in cases of distention from accumulation of gas, the abdominal wall is often very tense. The percussion note is tympanitic and from this the differential diagnosis is made between these conditions and solid tumors and cysts in which condition the note is dull.

A **relaxed abdominal wall** may be the result of over distension or stretching of it, the accumulation of fat or general weakness. The most common form is the result of pregnancy in which the walls are in a sub-involuted condition in which cases, they fail to regain their former tone. In nulliparæ, the relaxed abdominal wall is diagnostic of enteroptosis. The degree of relaxation of the wall is indicative of the degree of relaxation of the supports of the intestines. Often the accumulation of fat in the abdominal wall causes it to relax and gives the patient a pendulous appearance, and in such cases there is usually a great deal of fat in the omentum and the intestines. In a general way then, a fat abdominal wall is indicative of the accumulation of fat around the intestines; a relaxed abdominal wall, of a relaxed condition of the supports of the intestines; while a contractured abdominal wall is indicative of an irritation of the peritoneum caused most frequently by chronic catarrh of the bowel. A localized contracture or hardening of the wall is suggestive of an irritative disease of the part in relation, or a contracture of the abdominal, or if deep, of the psoas muscles. If the thickening of the tissues or tumefaction is not superficial, it is indicative most frequently of an impacted bowel or a congested viscus or in some cases, an enterolith. The localized relaxation is suggestive of a thinning of the abdominal wall at that point and predisposes to hernia, particularly if it is near the umbilicus or abdominal ring.

The **temperature** of the abdominal wall should be taken into consideration in the examination of a patient. If the temperature is above normal, it is indicative of peritonitis, the degree of temperature determining the degree of inflammation. If this occurs in the lower part of the abdominal wall, it is indicative of inflammation of the pelvic peritoneum caused by ovarian or uterine disease. If localized in the right iliac fossa, it suggests peritonitis from appendicitis. If in the neighborhood of the umbilicus, it is probably a case of inflammation of the bowels. Only in incipient peritonitis, is the increase of temperature localized, while a general rise of temperature is indicative of a diffuse peritonitis. In children suffering with indigestion, the surface temperature is often increased to a greater degree than that of any other part of the body. By

manipulation of the intestines by which they are lifted or changed as to position, this temperature can be reduced, often at a single treatment. In the treatment of children for such a disorder, the abdominal manipulation is the most important of all treatments. A **coldness** of the abdominal wall, is, according to Dr. Still, the result of a displacement upward or to one side, of the omentum, which is an apron like flap which separates the abdominal wall from the intestines, thereby protecting them against injury and perhaps against change of temperature. In many cadavers examined by the writer, the omentum was found rolled up and displaced upward or to one side. The coldness of the abdominal wall is found in cases in which the vitality, that is, the activity of the intestines and other abdominal viscera is lessened. In subinvolution of the abdominal wall and pelvic organs, the parts feel cold to the touch and often there is a cold perspiration on the surface.

The **areas of tenderness** in the abdominal wall are suggestive of a congestion or inflammation of the viscera in relation. This painful condition is often reflex, but in many cases it is the result of the inflammation extending by contiguity of tissue, from the visceral to the parietal layer of the peritoneum. It is practically impossible for tenderness or inflammation of a viscus to occur without the abdominal wall becoming affected, that is, it becoming tender also. A general tenderness of the abdominal wall is indicative of a diffuse peritonitis, or a general disease of the intestines as in cases of sudden cessation of the menses or chronic catarrh of the bowel. A localized tenderness over the pit of the stomach, that is over the sub-sternal angle, is about as good a diagnostic indication of gastritis or some other organic disease of the stomach as there is. In mild cases the tenderness is most marked in the deep structures, while in acute cases, the integument over this area becomes so tender that the patient can scarcely bear the weight of the clothing on the part. Tenderness between the pit of the stomach and umbilicus, that is, about midway between, is suggestive of an organic disease of the small intestine. If this tenderness seems to follow a horizontal course, it is in the transverse colon. A tenderness in the right hypochondriac region is suggestive of congestion of the liver or of gall stones. Often there is a localized area of tenderness just above and to the right of the umbilicus, at which point the gall-duct empties into the duodenum; this is suggestive of catarrh of the gall bladder, or of gall stones. In appendicitis, the tenderness is over McBurney's point. This may be confused with that from

ovarian disorders, which usually is at a point somewhat lower than this. Tenderness in the **iliac fossæ** occurs in congestion, inflammation or organic disease of the peritoneum, tubes, and ovaries. **Supra-pubic** tenderness is suggestive of congestion or inflammation of the uterus or organic

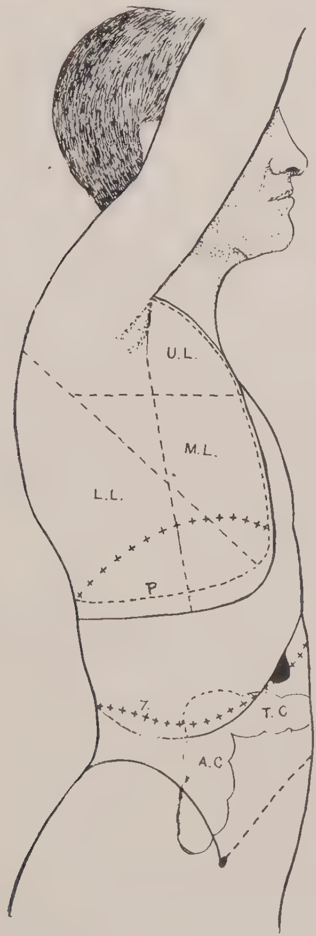

FIG. 134.—Surface markings of the thoracic and abdominal viscera (right side). U. L., upper lobe of right lung. L. L., lower lobe. M. L., middle lobe. P., lower boundary of the lung. 7., lower border of liver. A. C., ascending colon. T. C., transverse colon. (After Eisendrath).

disease of the bladder. Tenderness of the abdominal wall may occur in cases of strain of the muscles, hernia, Pott's disease involving the thoracic vertebræ and fracture or dislocation of the lower thoracic vertebræ. In the examination for abdominal tenderness, ascertain whether it is superficial or deep, also the degree of it, location and length of standing.

In lesions of the lower ribs, often the pain is referred to the abdominal wall, but in these cases, pressure will not ordinarily increase the pain. Pseudo-appendicitis is a very good example of this type of disease and in many cases of supposed ovarian and gastric disorders, the pain is a referred one.

In many disorders of the abdominal and pelvic viscera, there is a marked pulsation of the arteries which supply the parts. This pulsation is due to a constriction of the vessel from a thickening of the walls or else to a stimulation of the vaso-constrictor nerves supplying the part. **Pulsation** at the **pit of the stomach,** is indicative of congestion or inflammation of the stomach, if immediately above the umbilicus, of disorders of the **small intestine.** In chronic ovarian disorders, there is pulsation and thickening of the iliac arteries, which things can be determined in an average case by palpation over them. The writer has examined many cases in which the artery could be distinctly palpated, being hard and large and considerably larger than the corresponding one. In thin people, care should be taken not to mistake the normal pulsation of the abdominal aorta for an aneurysm or other pathological conditions.

The function of the abdominal wall is to support the abdominal viscera as well as protect them against injury. If the wall is relaxed it does not well support or protect, hence displacement of the viscera is the result. Its function is also disturbed by contracture of the wall whether from lesions or visceral disease, and the contour of the abdomen is thus altered. Lesions along the lower thoracic region involving the vertebræ and ribs, disturb the function of the abdominal wall in that they interfere with the innervation of its muscles. On this account the muscles will become contractured or relaxed, both of which disturb function.

THE TEMPORO-MAXILLARY ARTICULATION.

The **temporo-maxillary** articulation is formed by the glenoid fossa and the edge of the temporal bone or eminentia articularis, and the condyle of the lower jaw. This articulation is of importance on account

of the frequency of dislocation or injury and the effects on the fifth cranial nerve. The **ligaments** are the capsular, which is divided into several portions such as the external lateral and internal lateral; the interarticular cartilage; the spheno-maxillary and the stylo-maxillary. The two lateral ligaments in addition to holding the bone in place, protect the internal maxillary vessels and the auriculo-temporal nerve, during movements of the lower jaw. The interarticular fibro-cartilage acts as a buffer and prevents shocks to the brain, as in the violent closing of the jaw or blows on the chin, which would otherwise injure the brain through

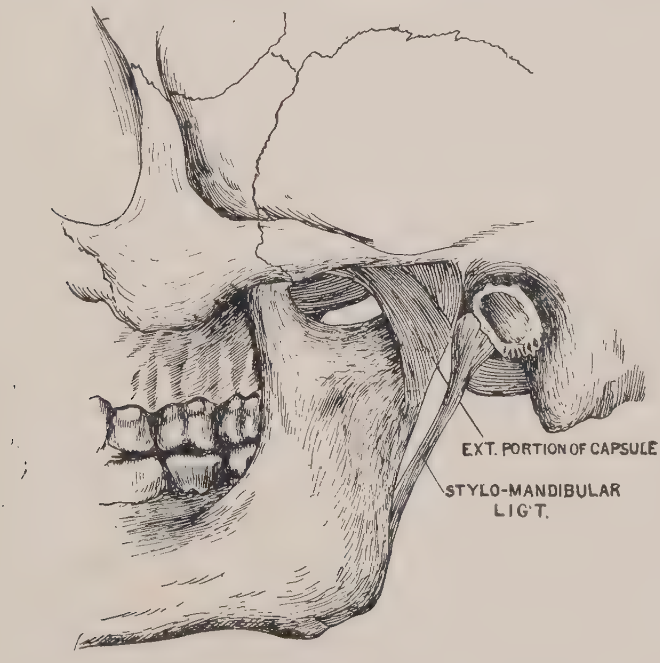

Fig. 135 —Showing the temporo-maxillary articulation.

the thin bony plate of the glenoid cavity which is in relation with the middle fossa of the skull. This joint is innervated by branches of the fifth nerve, and on this account the effects of a lesion would be most pronounced in the area supplied by this nerve. The **movements** of the joint consist of a hinge-like movement with a slight gliding action and some rotation. These movements are necessary for the proper triturat-

ing of the food. The muscles concerned in the movements of the jaw are:

Depressors. The platysma myoides, the mylo-hyoid, the genio-hyoid, the anterior belly of the digastric and the genio-hyo-glossus.

Elevators. The masseter, the temporal and the internal pterygoid. The lower jaw may be protruded or retracted by the fibro-cartilage and the condyles gliding forward and backward in a horizontal direction. The forward movement is produced by the contraction of the external pterygoid assisted by the masseter and the internal pterygoid. Retraction is effected by the posterior part of the temporal and a part of the masseter. The grinding movements are accomplished by the alternate contractions of the internal and external pterygoid muscles on each side.

In all ordinary movements of the jaw the fibro-cartilage is held in relation with the condyle, but if the depression of the jaw is marked as in yawning, the condyle may be dislocated forward. The external pterygoid muscle has to do with holding the bone out of place, thus the jaw is locked in its abnormal position. McClellan says: "A proper understanding of the mechanism of this displacement is necessary for its reduction, which demands that the lower jaw be drawn forward, forcibly depressed and then pushed backward and upward. The dislocation of the jaw comes most frequently from force applied to the jaw when the mouth is open, but perhaps more frequently from the spasmodic action of the external pterygoid muscle in yawning." The **signs** of the dislocation are a widely opened mouth, which cannot be closed, pain and swelling of the joint and dribbling away of the saliva. A subluxation of the jaw is more common than a complete displacement. It consists of a slipping forward of the interarticular cartilage upon the eminentia articularis as a result of rupture or relaxation of the ligaments. This occurs most frequently in young and delicate people in which the ligaments are relaxed. In this case the condyles catch and temporarily lock the jaw, which after loosening cause the jaw to be closed with a snap. In most cases the two sides of the jaw are not depressed symmetrically, that is the symphysis is drawn out of the median line. These partial dislocations can be diagnosed by noting the character of the movement, which is best done by placing the hands over both articulations while the patient opens the mouth.

As a result of these lesions, not only is the function of the joint impaired but the structures in relation are injured or in some way affected.

These structures are the parotid gland, the fifth nerve and the temporo-maxillary artery. Often **facial neuralgia** is the result of a subluxation at this joint which irritates the fifth cranial nerve. The pain is often referred to the teeth, or the points on the face at which the nerve is superficial. Some disorders of the **parotid gland** result from a lesion of the lower jaw by which the gland is directly injured or affected through its innervation, and becomes tender and congested and gives rise to symptoms similar to those in mumps. The writer has seen many cases of **erysipelas** of the face in which the trouble was undoubtedly due to subluxation of the inferior maxilla, since in nearly all of them the condition was relieved within a short time by correcting this lesion. The possible explanation is that the vaso-motor nerves to the superficial blood-vessels of the face are in some way affected by a subluxated condition of the bone, hence the marked congestion which is the first sign of the disease. In addition to this we should consider the micro-organism which is supposed to be responsible for the disease in that it is the exciting cause.

In reducing this lesion it may be necessary to introduce a cork or the finger wrapped with a towel, between the last molar teeth and then by using this as a fulcrum and the jaw as a lever,the head of the bone can be pried back and down into its socket. In cases of subluxation, the lesion can be reduced by using the angle of the jaw as a lever and producing some pressure on the articulation as the mouth is opened.

THE HYOID BONE.

The **hyoid bone** acts as a stay for the support of the numerous muscles attached to it, therefore its position is dependent on the condition of the muscles attached to it. It consists of a body and four cornua. The greater cornua can be palpated just above and to the side of the thyroid cartilage. Each projects upward and backward and terminnates in a round tubercle to which is attached the thyro-hyoid ligament. This bone is of interest in that injuries to the throat as in choking, disturb its position and consequently disorders of the voice and difficult deglutition result. In contracture of the hyoid muscles, for example the omo-hyoid, **aphonia** often results. Therefore in cases of huskiness of the voice, loss of voice, chronic hacking cough or even painful conditions of the throat, this bone should be examined, because in these disorders it is often found to be displaced. These effects are explained by

the fact that the muscles attached to it are contractured and that the nerves in relation are affected, particularly the superior and recurrent laryngeal. Contractures of these muscles put a tension on the voice-box, thereby interfering with its function, while in other cases they pull the bone backward against the nerves in posterior relation, thereby setting up an irritation of them. In whooping cough, this bone is often found displaced upward and backward and the severity of the paroxysms can be lessened to a marked extent by drawing it down into its normal position. By grasping the cornua and pulling them downward and forward thereby stretching and overcoming the contracture of the tissues above the bone, the irritation can be relieved or at least lessened in intensity. In some cases the two ends of the bone may not be of the same length, this giving rise to an irregularity that may be mistaken for a lesion.

THE STERNO-CLAVICULAR ARTICULATION.

The **sterno-clavicular** articulation is quite shallow and on this account the clavicle is subject to displacement. The ligaments permit of considerable movement when the shoulder and arm are used. It is frequently slightly displaced and coupled with this is often found hypermobility, so that it is possible, by grasping the middle third of the clavicle, to move the sternal end of the bone through a space of half an inch. The most common lesion of this articulation is a backward displacement of the sternal end of the clavicle. This is diagnosed by feeling it in its abnormal position, and noting that it is less prominent than the opposite side. This sort of displacement may produce dyspnea, dysphagia or congestion of the head and face from pressure on the trachea, esophagus or the veins of the neck. Goitre is supposed to be produced, or made worse by a downward or backward displacement of this end of the clavicle. In some of these cases, the upward displacement of the first rib is the real condition rather than a displacement of the clavicle. The distance between the clavicle and rib is lessened in either case and would lead to an obstruction of the vessels located between the two. The effects of this lesion are most pronounced in the veins which leads to congestion of the throat, thyroid gland and arm. In all cases of sore throat, exophthalmic goitre or enlargements of the neck whether from lymphatic disturbances or due to venous congestion, the clavicle should be examined, because in many of these, it is subluxated backward and downward and thus obstructs the drainage of these parts.

The effects of a lesion of this end of the clavicle are then determined almost entirely by the degree of pressure on the adjacent blood-vessels. A displacement of this end of the clavicle will weaken the shoulder in that the bone acts as a brace to the shoulder. On this account it is torn loose by strong muscular exertions in which the shoulder and arm are used.

THE ACROMIO-CLAVICULAR.

The **acromio-clavicular** joint is shallow and has a peculiar obliquity. It is of greater importance to the physician partly on account of the frequency of the subluxation and partly on account of the severity of the effects. It has the usual capsular ligament and the interarticular fibro-cartilage which is often imperfect. In all movements of the shoulder girdle, this articulation is involved. In movements of the arm, forward and backward and upward past the horizontal plane, this articulation is involved. The acromial end of the clavicle is most frequently dislocated upward and backward. As the result of such a lesion, the movements of the shoulder girdle are imperfect and many movements of the arm painful or impossible. The **arm can be raised to a level of the shoulder without the movement of this joint,** but whenever it is carried forward or backward as in combing the hair or putting on a coat, this joint is involved. If a lesion exists, these movements are practically impossible, but in the average case they are only painful so that the patient has difficulty in backward or upward movements of the arm. This lesion is often the cause of pain along the groove of the biceps and at the insertion of the deltoid, in which cases, the trouble is usually attributed to a slipping of the bicipital tendon in its groove. In cases treated by the writer it was found that in most of them in which a diagnosis of dislocation of the bicipital tendon was made, there was found to be a lesion at the acromio-clavicular articulation. This lesion not only disturbs the function of the joint, that is, movements in which this joint is used, but it seems to affect the circumflex and other nerves in relation. This gives rise to a referred pain which is felt at the insertion of the deltoid along the tendon of the biceps and over the top of the shoulder. The patient often describes it as "rheumatism" of the shoulder on account of the stiffness and pain. **In all cases in which a patient cannot get the hand to the back of the head or the spine, or cannot extend the arm above the head, it is well to examine this articulation,** since in most of them there will be found a tenderness and irregularity at the acromio-clavicular

joint. Reduction is as a rule, easily effected by drawing the shoulder and arm up and back and at the same time applying some pressure over the acromial end of the clavicle. In cases in which it does not stay in place, it is well to bandage the joint and strap the arm to the side.

THE SHOULDER-JOINT.

The **shoulder-joint** is formed by the head of the humerus and the glenoid fossa of the scapula. It is an enarthrodial or ball-and-socket joint, and the movements are freer than those of any other articulation. The glenoid fossa is deepened by the glenoid ligament and even in this condition, is much smaller than the head of the humerus, which accounts for the great freedom of movement. The capsular ligament is attached to the circumference of the glenoid cavity and to the anatomical neck of the humerus below. It is very loose and large and in fact is large enough to accommodate the head of the femur. In dislocations of the humerus, this ligament is ruptured at the lower part, which is the weakest portion. The coraco-humeral or accessory ligament, seems to be a thickening of the inner part of the capsular ligament which extends from the coracoid process to the tuberosity of the humerus. The glenoid ligament is a fibro-cartilaginous rim which surrounds the edge of and deepens the glenoid cavity. It is continuous above with the long head of the biceps tendon and below with the long head of the triceps. These ligaments do not securely hold the head of the bone in position, but the tendons of the muscles in relation, so reinforce them that the head of the bone is thoroughly well held in place. The important **tendons** are those of the supra-spinatus, infra-spinatus, and teres minor muscles, posteriorly; the broad tendon of the subscapularis strengthens it on the inner part; the long head of the triceps below and the long tendon of the biceps strengthens the upper anterior part of the joint. In addition to these, the deltoid covers over the entire joint and strengthens and protects it.

The **synovial membrane** lines the ligaments of the joint and sends a reflexion around the long tendon of the biceps and communicates with the bursal sacs around the tendons in relation. In injury to the shoulder-joint, the synovial sac often becomes distended with fluid and thus produces a fluctuating swelling around the joint. This is often followed by adhesions or dryness of the joints in which there is crepitus. Care should be taken in the treatment of chronic synovitis of the shoulder-

joint because of the danger of making it worse by the breaking of adhesions.

The **blood-supply** of the joint is derived from the suprascapular, anterior and posterior circumflex and subscapular arteries. It is **innervated** by the suprascapular, circumflex and a few filaments from the subscapular nerve. McClellan says: "The shoulder-joint is practically a universal joint and as it depends upon the arrangement and power of the surrounding tendons rather than upon the mechanical adjustment of the opposing bony surfaces, the grouping of the muscles in effecting the various movements should be understood. Extension is effected by the teres major, latissimus dorsi and the posterior third of the deltoid. These

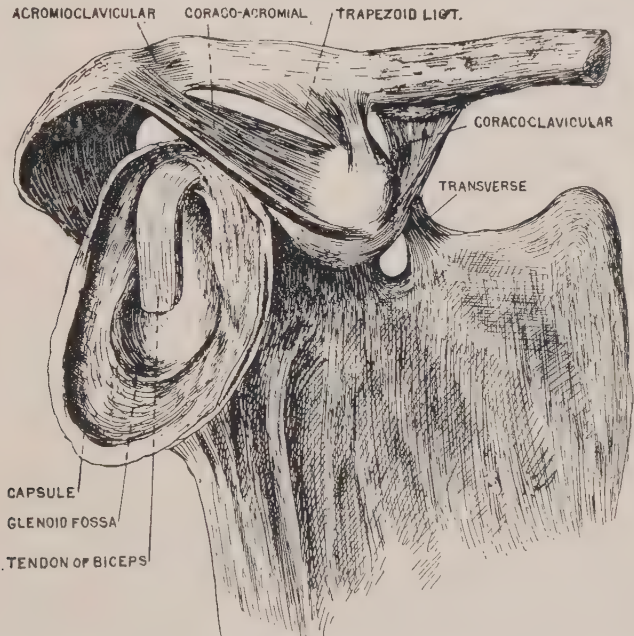

FIG 136.—The glenoid fossa, scapula, clavicle, and acromio-clavicular articulation.

are assisted in raising the arm by the teres minor and infraspinatus muscles. Flexion is produced by the coraco-brachialis and the anterior portion of the deltoid aided by the pectoralis major; abduction by the deltoid and supraspinatus; adduction by the pectoralis major, teres minor, latissimus dorsi and coraco-brachialis."

On account of the shallowness of the glenoid cavity, the powerful leverage exerted on the joint by the arm as in protecting the body in falls, the large size and rounded shape of the head and the looseness of the ligaments, dislocation of this joint is comparatively very common. It is caused most frequently by forcible extension as in falls on the hand or elbow and twists of the arm. Sometimes a direct blow on the shoulder will dislocate the humerus. The form of the dislocation is determined by the position of the head of the bone in relation to the glenoid cavity. Thus, there may be **four forms of dislocation;** the subcoracoid, in which the head is forward and slightly downward; the subglenoid, in which it is directly under the cavity; the subspinous, in which it is back and the subclavicular, in which it is anterior. The other dislocations are only modifications of these.

The **signs** of dislocation of the shoulder, depend upon the length of standing of the case and the character of the injury. In all recent cases there is swelling, lessened mobility, pain in the joint and along the course of the arm and no crepitus. There is prominence of the acromian process with a depression immediately beneath, a flattening of the shoulder, a change in the direction of the humerus and on palpation, the head of the bone is found to be at a place elsewhere than in the glenoid cavity. The usual tests for dislocation of the shoulder are, the strait edge test in which a straight edge applied to the shoulder will touch the arm and acromian process; increased circumference of the joint and limitation of the movements of the arm, so that when the hand is placed on the opposite shoulder the elbow will not touch the chest; and palpation of the bone in its abnormal position.

The **subcoracoid**, is the most common of the displacements of the shoulder. In this dislocation, the head of the bone is anterior to the glenoid cavity and under the coracoid process. It is diagnosed by feeling the head of the bone in this position and by noting the prominence of the tissues caused by the abnormal position. The limb may be shortened, but it is in many cases not affected at all as to length. There seems to be all grades between the subcoracoid and **subglenoid** displacements, the latter being the next most common form. The diagnostic points of this form are, the presence of the head of the bone under the glenoid cavity, that is, in the axilla, marked depression over the anterior part of the axilla, lengthening of the arm and quite a large depression between the head of the bone and the coracoid process.

The other forms of dislocation of the shoulder are very rare. The most important of the diagnostic signs, is the abnormal position of the head of the bone, which can be palpated and seen in its changed position.

Most important as well as most constant of the effects of a displaced shoulder is the interference with the function of the joint, that is, loss or

FIG. 137.—Dislocation of the shoulder with atrophy, paralysis and deformity. The fingers were stiff, flexion of the wrist impossible and pain in the shoulder-joint, very great. Under treatment, the pain was relieved but reduction was found impossible on account of the great amount of inflammatory tissue around the joint. (From photo).

restriction of movement. In order that a joint may have normal movement, the articular surfaces must be in contact and if they are changed, the disturbance of movement is usually in proportion to the degree of

change. In dislocation of the shoulder the articular surfaces are of course separated and otherwise changed, hence the limited movement of the arm. Adhesions occur in many cases as a result of the irritation and inflammation, which so commonly accompany a displacement of the humerus. These adhesive bands still further restrict the movements of the shoulder and often have to be broken up before reduction is possible. Probably the best way to do this is by repeated stretching and manipulation of them, by which they are gradually torn and absorption hastened.

Atrophy of the muscles of the shoulder occurs in every chronic case, partly on account of the impairment of the vessels and nerves to these muscles and partly on account of non-use. The muscles first affected and in which the atrophy is greatest, is the deltoid. This is on account of its innervation more than anything else, since it is supplied by the circumflex nerve, which is the main supply of the shoulder-joint and its ligaments. In dislocation of the shoulder, the shoulder-joint is injured and consequently the circumflex nerve, and the above atrophy is one of the effects. If other nerves of the brachial plexus are involved or if the arm and hand are held in a fixed position for too great a length of time, contractures producing deformities will result. In some cases bandaging of a shoulder or arm will lead to these contractures and deformities. These deformities can be prevented in most instances by proper care, that is, passive movements being resorted to in cases in which the patient is unable to use the arm. Another effect which is chronic, is that of repeated dislocations. One dislocation makes it easier for another to occur on account of the relaxation of the ligaments and injury to the tissues of the joint. This weakness or relaxation may be in part the result of lesions of the upper thoracic area that interfere with the nutrition of the joint.

Partial dislocation of the shoulder is a condition in which the ligaments that hold the head of the bone in place are so relaxed that they permit the bone to drop away from its socket or else the bone has been forcibly twisted in the socket, thereby injuring the ligaments. The first is the result of a general weakness or local disorder due to lesions of the upper thoracic area affecting the trophic nerves to the joint, or to a repeated dislocation or injury of the shoulder. In recent cases, the head of the bone may be pulled to one side of the socket, or it may become twisted, either of which constitutes a partial dislocation. As in the case of the hip, it seems that the head of the humerus is either in or out of the

socket, but clinically, it is a fact that the head may become twisted in the glenoid cavity, this interfering with the function of the joint. In these cases of partial dislocation of the shoulder-joint, only some of the movements are impaired. The ordinary movements of the arm may be normal, but if the patient should attempt an exaggeration of any of these normal movements there will be restriction and pain. The pain in these cases may be a continuous ache referred to the area of distribution of one of the brachial nerves, or it may be a sharp pain on certain attempted movements. The sensory disturbance may be confined to the shoulder-joint in which case it is often called rheumatism of the shoulder. Some of the trophic disorders of the arm can be attributed to a partial dislocation of the head of the humerus.

THE ELBOW.

The principal disorder of the elbow consists of a partial **dislocation** of the **head** of the **radius.** This is characterized by pain along the course of the nerve in relation, numbness or perverted sensation in the part and in many cases, by some trophic disorder, such as caries of the bone, or some eruptive disorder of the skin covering the forearm. It is diagnosed by locating the head of the bone in an abnormal position, pain over the part and by restriction of movement. In complete dislocations of the elbow, both the bones of the forearm are dislocated backward on the humerus so that the coronoid process of the ulna is in the olecranon fossa and the neck of the radius on the capitellum of the humerus. In such a dislocation the joint locks whenever extension is attempted and the olecranon process, that is the elbow, becomes very prominent. Another form of lesion of the bones of the forearm consists of an approximation of the upper ends of the bones. This condition is diagnosed by palpation by which the distance between them is ascertained, and by pain and tenderness along the tissues between the bones. In many cases in which the symptoms and conditions are obscure, it is well to examine either for a partial dislocation of the radius or an approximation of these two bones.

THE WRIST.

The principal disorder of the **wrist-joint** is a sprain, or in some cases a partial or complete dislocation of the joint is found. This occurs on account of falls in which the patient attempts to protect the body by

catching himself on the hand. By doing this the movement is carried beyond the physiological range, therefore the ligaments are either torn or over-stretched. This results in a thickening and an exudation. In

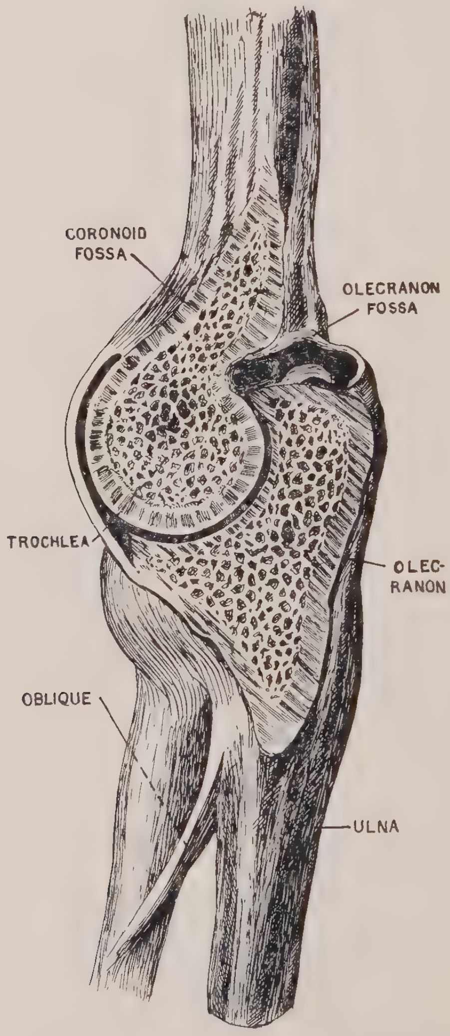

Fig. 138.—Showing longitudinal section of the elbow-joint.

such cases it is advisable to examine for a fracture of the radius, since such is accompanied by swelling of the joint, which is identical with that of a sprain. In partial dislocations of the wrist there will be found slight irregularity, some restriction of movement and tenderness. The effects of an injury to this joint are stiffness, or weakness of the articulation, pain and swelling.

THE HAND.

The **carpal** bones are seldom misplaced, but the os magnum occasionally is forced backward in extreme flexion of the hand. It is characterized by prominence of the bone which may be mistaken for a weeping sinew, or a ruptured tendon. It seldom produces any trouble further than that of weakening the hand or producing pain at certain movements or when a strain is thrown on that part.

The **phalanges** of the hand are quite often sprained or dislocated, particularly the thumb. This is the result of direct violence or from hyperextension. The diagnosis is comparatively easy on account of the signs, they being abnormal position, swelling, pain and limitation of movement. The thumb is subject to sprains which result from blows on the end of it or hyperextension. The principal articulation involved is the one between the first phalanx and the metacarpal bone. The effects are hard to overcome, they consisting in the main of a thickening, congestion and extreme tenderness of the ligaments.

THE UPPER EXTREMITY AS A REGION.

The upper extremity as a region. The **skin** of the arm is quite thin and freely movable. On this account the veins stand out in prominence and cutaneous eruptions are rare. The surface markings of the principal arteries and veins and nerves is important, since compression of the vessels and inhibition of the nerve, can be done to better advantage if the external markings are well known. The brachial artery is indicated by a line drawn from the inner border of the biceps or posterior axillary fold, to the center of the elbow. A line from this point to the scaphoid bone represents the radial, while one drawn to the pisiform, the ulnar artery. The course of the median nerve is the same as that of the brachial artery. The posterior circumflex nerve and artery are in relation with the insertion of the deltoid muscle.

The **ulnar nerve** corresponds to a line drawn from the lower part of

the axilla or apex, to the internal condyle, thence along the under side of the arm in relation to the flexor carpi ulnaris tendon. The **musculo-spiral,** corresponds to a line drawn obliquely around the upper part of the arm, it crossing the humerus at the junction of the middle and lower thirds.

The **lymphatics** accompany the veins, those from the forearm emptying into the glands at the angle of the elbow, while those of the upper arm, empty into the axillary glands. The superficial veins form quite a net work in the integument of the arm and in some people in whom the skin is thin, the veins are very prominent. In infections of the hand and forearm, the superficial lymphatic vessels and sometimes the veins become inflamed and are characterized by red lines that lead upward from the point of infection.

The **contour** or external configuration of the arm depends on the age, sex and occupation of the individual. In children and females, it is about cylindrical on account of the lack of development of the muscles and the deposit of subcutaneous fat, while in adults in whom the muscles are developed, the arm is flattened from side to side. The development of the supinator longus, pronator radii teres, triceps and the biceps muscles, changes the contour of the arm to a marked degree. The tendon of the biceps makes a triangular depression in front of the elbow called the antecubital fossa and is of interest in that the brachial artery and median nerve are in relation. At the insertion of the deltoid muscle is another depression at which place pain is usually referred in disorders of the shoulder-joint or brachial plexus. At the back of the elbow is a slight depression when the arm is extended, which marks the articulation of the radius with the ulna, and furnishes a landmark in the examination of this articulation. The prominence of the elbow is formed by the olecranon process of the ulna. On the inner and posterior side of of the ulno-carpal articulation is a prominence formed by the styloid process of the ulna. In dislocations and fractures at or near this joint, this prominence serves as a landmark in locating the joint and in the differential diagnosis.

The upper extremity is subject to change in contour from many diseases. If the **nails** are abnormally convex, both transversely and longitudinally, it is symptomatic of tuberculosis. In such cases if the nails were allowed to grow they would become clawed. If they are brittle and have white spots in them it is indicative of malnutrition. If

they are very short, it is suggestive of nervousness, since nervous people often bite the nails, to the quick. If the **fingers are clubbed** and the nails short, it is suggestive of organic heart disease. This applies particularly to children in which the nail is broad and short, and is found especially in the congenital types of valvular diseases of the heart. A **dactylitis** is almost diagnostic of hereditary syphilis or tuberculosis. A dactylitis

FIG. 139.—Showing the condition of the hands and forearms in a marked case of progressive muscular atrophy. (From photo).

consists of an inflammation of the finger or toe and is characterized by an enlargement of the joint and often by the formation of a small ulcer. In the hereditary form, the development of the finger is interfered with when it appears to be short and stumpy.

If the joints of the fingers are enlarged and the hand everted, it is suggestive of **arthritis deformans.** In this disease the deformity very often reaches a marked degree so that all the fingers are drawn out of shape. In certain injuries to the palmar fascia, contraction may result

which draws the little and ring fingers into the position of extreme flexion. This produces a deformity which is quite characteristic and easily diagnosed on account of the thickening of the fascia of the palm of the hand. This is called **Dupuytren's** contraction. A flattening of the **thenar** and **hypothenar** eminences, is almost diagnostic of progressive muscular atrophy. If this is accompanied by a softening of the tissues of the hand and atrophy of the adductor muscles of the thumb, and the hand becomes very thin, it is diagnostic of **chronic anterior polio-myelitis.** The swelling of one or more joints of the hand occurs in chronic rheumatism and in gout. The diagnosis is based on the other symptoms.

There are certain motor disorders which are common and fairly diagnostic of nervous and other diseases. Spasmodic or convulsive movement of the hand and arm occurs in chorea. This is usually accompanied by some movement of the head, neck and shoulders. It is usually unilateral but may affect both arms. A constant movement of the forefinger and thumb is suggestive of **paralysis agitans.** This occurs in the aged. **Athetoid** movements of the hand and wrist occur in hysteria and in certain nervous diseases. They may be the result of infantile cerebral palsy or of lesions which affect the muscles of the hand. The effects are peculiar in that the fingers assume curious and unusual positions such as extreme flexion, pronation, extension, tortion and supination.

Intentional tremor is indicative of spinal cord disease especially disseminated sclerosis. Tremor of the hands and arms is found in Graves disease, often during senility and in patients suffering from hemiplegia. Certain forms of nervousness are characterized by tremor of the hand. Hare says: "There are two sets of movements associated with the movements of the muscles of the wrist and hand which possess grave prognostic and diagnostic importance. The first of these is twitching of the muscles of the forearm (subsultus tendinum). It indicates severe exhausting disease. The second is picking at the bed clothes. This is called carphologia. It is a grave symptom and usually is indicative of approaching death." Inco-ordination of the movements of the hand and arm occurs in some cases of locomotor ataxia. It may result from a neuritis or upper thoracic lesions, the differential diagnosis being based on the other symptoms of tabes dorsalis.

Contractures of the muscles and tendons of the hand and wrist and those of the elbow, result from dislocations of the shoulder and from trauma. In some cases these are the result of hysteria. Rigidity of the

parts occur in some cases of chronic hydrocephalus. In epileptic spasms, the clonic contractions peculiar to this disease. **Monoplegia** or paralysis of one arm or hand, results from hemiplegia, injury to the brachial plexus or in certain spinal cord disturbances. The writer has had cases of mono-

Fig. 140.—Showing a lesion at the articulation between the second and third thoracic vertebra. The patient fell from a bicycle, striking on the back of the neck. In about one year, symptoms of progressive muscular atrophy set in and at the time of the taking of the photo, the disease was well under way. Note the lateral deviation and break at the point of the arrow. (From photo).

plegia in an upper extremity that were due to upper thoracic lesions. In other cases, there is found a dislocated shoulder or injury to the brachial plexus as in obstetric paralysis. Pressure of growths in the axilla, will also lead to paralysis of the upper arm type which is sometimes called Erb's paralysis. Ordinarily complete motor and sensory paralysis of one upper extremity, is indicative of injury to the brachial plexus. If other parts of the body are involved it is suggestive of hemiplegia while in some cases, it is the result of upper thoracic lesions. Impairment of movement and weakness of the arm, most frequently result from upper thoracic lesions and from repeated dislocation of the shoulder. If it affects only one side it is probably a shoulder disorder, but if both sides are involved, it is most probably the result of a disorder of the spine.

The **cutaneous nerves** of the upper extremity are the supra-clavicular, circumflex and intercosto-humeral, internal cutaneous, nerve of Wrisberg, musculo-spiral, musculo-cutaneous, median, ulnar and small branches from the principal divisions of the brachial plexus. The deep innervation comes principally from the main trunks of the brachial plexus, as the circumflex, musculo-spiral, musculo-cutaneous, ulnar and median. The upper extremity is subject to many sensory disturbances, some of which are local and some reflex. Certain visceral diseases tend to produce pain in the arm, as is the case of cardiac disease in which pain is referred to the area supplied by the left ulnar nerve. Pain is also referred to the arm in cases of dislocation of the shoulder, of the acromial end of the clavicle and from subluxations of the upper thoracic vertebræ. A lesion of the upper ribs will produce pain or an ache in the shoulder, this sometimes extending down the arm. The explanation of most of these referred pains lies in the fact that the sensorium is often mistaken as to the origin of the sensory impulses carried to it and they are referred to the periphery of the nerve. In the case of a lesion of the upper thoracic vertebræ, the sensory impulses that arise from it are carried to the sensorium and the pain is referred to the periphery of the nerves in relation, that is, to the brachial nerves. Pain along the tract of any of the brachial nerves may be due to a tumor on the nerve, or irritation from other causes, as infection, inflammation, or displacement of the shoulder or vertebra with which it is in relation. Neuralgic conditions, or aches in the nerve, are ordinarily due to congestion of the nerve trunk and the pain is increased by pressure along the nerve. A

throbbing pain indicates an acute congestion of an area in which the elasticity of the tissues is lessened. Each beat of the heart forces more blood into the already congested vessels and thereby the pain is increased with each heart beat.

FIG. 141 —Showing a subluxation of the third dorsal vertebra. Note the "break" at the point of the arrow. The lesion was produced by trauma and in a short time, symptoms of progressive muscular atrophy began to develop. At the time of the taking of the photo, three years after the accident, the disease was well developed. (From photo).

Parasthesia of the arm, that is perverted sensation in which there is tingling and numbness, is most frequently due to direct pressure on the nerve trunk. This comes from a displacement of some of the bones with which the brachial nerves are in relation, as in the case of the humerus, clavicle, radius and ulna. The writer has treated a few cases of parasthesia of the arm due to lower cervical and upper thoracic lesions. The explanation of the effect is that the displaced bone presses directly on the nerve trunk or vessels supplying it or else interfere with the sensory cells of the ganglion on the posterior root. In some forms of heart trouble there is numbness of the ring and little fingers on the left side. In hemiplegia, especially in the early stages, the fingers become numb. In the aged, often there is found a tingling sensation or numbness of the hand and fingers. This may be due to a change in the arteries or to trophic disorders of the brain.

The arm is subject to **trophic disorders** as the result of spinal and peripheral lesions. The vaso-motor disorders will be considered along with the trophic since they are related. The trophic and vaso-motor centers for the upper extremity are located in the upper thoracic spinal cord. This is determined partly by clinical observation and partly by physiological experiments on animals. A lesion of the upper thoracic vertebral articulations and particularly the second and third, will produce vaso-motor and trophic changes in the arm. The explanation is that the lesion breaks the line of nerve connection existing between the spinal cord and the arm or else interferes with the nutrition of the cells constituting these centers. The peripheral lesions consist of dislocations of the shoulder and elbow. In other cases the nerve may be torn or otherwise injured by trauma so that its functions are impaired. Atrophy of one arm is most frequently the result of a neuritis of traumatic origin or dislocation of the shoulder. Inflammation and swelling of the arm are sometimes due to a spinal lesion. In ulcers and eruptions of the integument and in caries of the bone, examine carefully for subluxations of the bones with which the various brachial nerves are in relation. The writer has seen cases of what appeared to be eczema cured by correcting a displacement of the radius.

There are certain secretory disturbances of the upper extremity that are of diagnostic importance. Hypersecretion of sweat of the palms of the hands is fairly diagnostic of nervousness, which sometimes occurs in cases of constipation and the early stages of progressive muscular

atrophy. A localized dryness of the skin is suggestive of a local lesion such as a lower cervical or upper thoracic subluxation or displacement of the shoulder. Chaffing of the hands is due in part to disturbance of sebaceous secretion, that is, it is lessened. This may be a part of a general disturbance but often is a local one. These secretory disorders are dependent to a great extent, upon the amount and character of the blood circulating through the part.

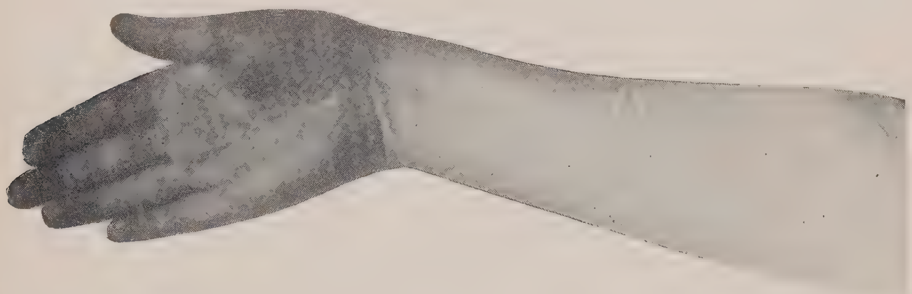

FIG. 142.—Showing a specimen of dermography. The letters were made by stroking the skin with a dull pencil. At first, there was a bright, red line followed by a welt, as shown in the picture. The condition was the result of an attack of measles in which the rash "went in." (From photo).

THE HIP-JOINT.

The **hip-joint** is formed by the acetabulum and the head of the femur. The acetabulum is a circular depression formed by the junction of three bones, the ilium, the ischium and the pubis. The ilium forms about two-fifths, the ischium a little more than two-fifths and the pubis the remaining one-fifth. It is directed downward, outward and forward but this varies somewhat in different cases. In the female and in "pigeon-toed" people, the acetabulum faces somewhat forward thus throwing the trochanters anterior. The margin formed by the cotyloid ligaments, increases the depth of the socket. The lower side is broken by a notch or depression called the cotyloid notch. On this account dislocations of the hip, occur at this point more frequently than at any other. Ossification of the bones forming the acetabulum begins quite early but is not completed until some time after birth. At the age of sixteen, ossification is usually completed. Anything interfering with this process during fetal life will often lead to the congenital form of dislocation of the hip.

The **head** of the femur is hemispherical in shape, quite smooth and glistening, being covered with cartilage except the part to which is attached the ligamentum teres. The **ligaments** of the hip-joint are the capsular and the ilio-femoral which is a part of the capsular, the cotyloid, the ligamentum teres and the transverse. The **capsular** ligament completely invests the joint, being attached above to the edge of the acetabulum and to the neck of the femur below. It is thickest and strongest over the anterior and external parts of the joint, since the strain on these parts is greatest, while below it is quite thin and loose. The **ilio-femoral** ligament, sometimes called Bigelow's or the Y-ligament, consists of a thickening of the anterior portion of the capsular ligament. It is attached above to the anterior superior spine and passing downward, it divides into two parts, on which account it is called the Y-ligament, it having the appearance of an inverted Y. One of these bands, the outer one, is attached to the anterior inter-trochanteric line near the trochanter, the inner one, to the lower end of this line. This ligament is seldom broken in the average dislocation and is of importance in that it acts as a fulcrum around which the movements of the head of the bone occur, and thus the different displacements are determined. The action and course of this ligament must be considered in the reduction of hip lesions.

The **cotyloid** ligament consists of strong bands of fibro-cartilaginous tissue which are attached to the edge of the acetabulum. It deepens and protects the cotyloid cavity and thus tends to prevent dislocation. The **transverse** ligament is really a portion of the cotyloid. It passes across the cotyloid notch and thus converts it into a foramen through which the vessels to the hip-joint pass. The **ligamentum teres** extends from the head of the bone to about the center of the acetabulum. It is not always present, but when it is, it is broken in dislocation. These ligaments of the hip-joint are subject to relaxation and contracture as are the ligaments of other joints. They may so relax that the bone will drop part way out of the socket, thus lengthening the limb, but this is not so common as in the case of the shoulder-joint. They do not have so much to do with holding the head of the femur in the socket as with limiting the movement of the joint. After section of these ligaments, air pressure will hold the head of the bone in place. The ligaments of the hip-joint help to economize the muscular effort in balancing the trunk.

The **muscles** in relation with the joint are: in front, the ilio-psoas; externally, the gluteus minimus and rectus femoris; internally, the obturator externus and pectineus, while the pyriformis, the two gemelli and the quadratus femoris are in posterior relation. A synovial membrane lines the entire capsule and the cotyloid ligament, and is reflected

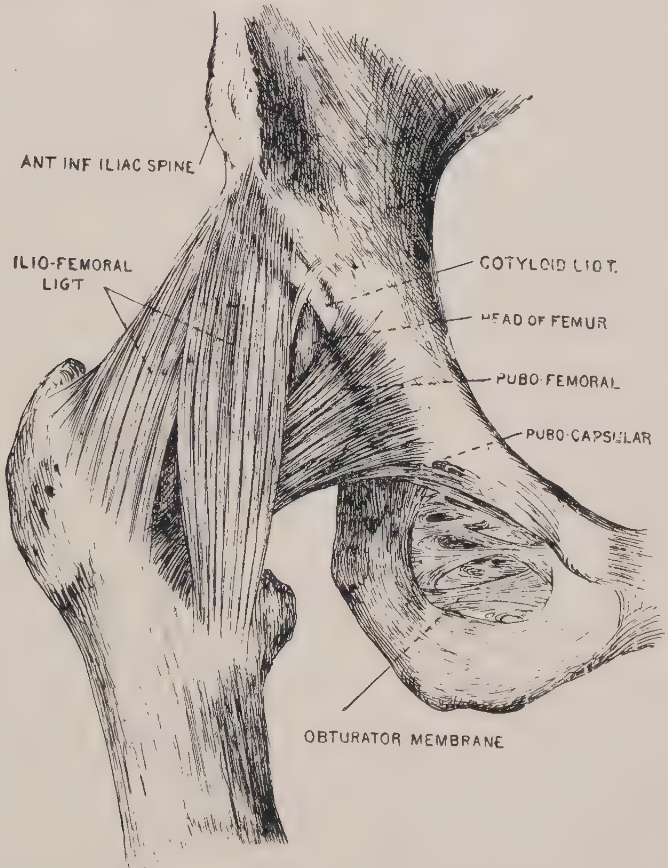

FIG. 143.—Showing the ligaments of the hip-joint Note the ilio-femoral.

over the articular surface of the head of the femur. In synovitis of the hip, the capsule becomes distended in cases in which there is much effusion and thus causes bulging in Scarpa's triangle and, backward into

the tissues, thus obliterating the gluteal fold. Movement of the joint is limited and the thigh tends to assume a position of flexion, inward rotation and adduction, this being the position of rest for the joint.

The **arteries** that supply the joint are derived from the obturator, gluteal, sciatic and internal circumflex. These are innervated principally from the lumbar spinal cord by way of the aortic plexus, which surrounds the abdominal aorta and sends off filaments with each branch of the iliac arteries.

The **nerves** supplying the joint are derived from the sacral plexus, the obturator, great sciatic and the accessory obturator nerve. The joint is an enarthrodial one and is capable of all forms of movement, although they are not so marked as in the case of the shoulder. Flexion, extension and circumduction are the principal movements. Flexion is limited by the contact of the neck of the femur with the upper edge of the acetabulum; extension, by the ilio-femoral ligament and circumduction, by the ligaments and muscles attached. Abduction and adduction are limited principally by the capsular ligament. Movement is also governed to a certain extent by the depth of the hip socket and the condition of the muscles and synovial membrane of the joint. The pathological conditions which interfere with the movement of the hip-joint are, dislocation, caries of the joint, non- or imperfect development of the socket, partial dislocation and painful conditions due to other causes, such as inflammation or sprain of the joint.

Dislocation of the hip may be either acquired or congenital, that is, taking place after birth, or incomplete formation of the acetabulum. The dislocations of the hip are usually classified under four forms: upward and backward or **dorsum iliac, sciatic, thyroid** and **pubic.** These dislocations result from exaggeration of the movements of the hip, that is, the femur is carried beyond the normal range of movement. In most cases the thigh is flexed and abducted when the dislocation occurs, thus forcing the heavier bone against the lower or weaker part of the capsular ligament. In the **iliac** form of dislocation, the head of the bone rests above and behind the acetabulum upon the posterior surface of the ilium. The lower and posterior part of the capsular ligament is usually ruptured and the round ligament broken. The glutei muscles and other external rotators, are usually torn or put on a stretch. These contractures interfere with reduction. The **diagnosis** of this form of dislocation is based on the position of the head and trochanter, length of the limb and

the disturbance of mobility. The head of the bone can often be palpated up and behind the acetabulum and the trochanter is abnormally prominent. The limb is slightly flexed, adducted and the toe turned inward so with the shortening which accompanies this dislocation the sole of the foot will rest on the arch of the other foot. The trochanter is usually above Nelaton's line, but this is not diagnostic of the displacement on account of the degrees of relaxation of the ligaments of the joint. External rotation of the thigh is limited or impossible, this depending, however, on whether or not the Y-ligament is torn. If this ligament is ruptured the toes are not necessarily inverted nor is external rotation impossible.

The **sciatic** form of dislocation is one in which the head of the bone rests in or just in front of, the sciatic notch. The head of the bone after being forced backward through the capsule, comes in contact with the tendon of the obturator internus muscle, which deflects the head into the sciatic notch, this tendon offering a great obstacle to the reduction of the dislocation. In this dislocation there is flexion, adduction and inward rotation, but all less pronounced than in the iliac form. There is some shortening of the limb, but not so much as in the dorsum iliac form, except when the patient is in the sitting posture and then the shortening is quite pronounced. The reason for this is that the head of the bone is displaced backward more than it is upward, therefore in flexion of the thigh, the shortening of the limb is exaggerated. Sometimes the head of the bone gets locked in the sciatic notch, thus making reduction impossible. This form of dislocation is very painful.

In the **thyroid** dislocation, the head of the bone is displaced downward into the thyroid foramen, it resting upon the obturator externus muscle. The glutei, ilio-psoas, adductor brevis, pyriformis, obturator externus and pectineus muscles are either torn or stretched by this form of displacement. There is eversion of the foot, lengthening of the limb and internal rotation is limited, or is impossible in some cases. The head of the bone can be palpated in its abnormal position and the trochanter is turned backward. The peculiar posture of the patient is the result of an attempt to relax the ilio-psoas muscle.

The **pubic** form of dislocation is rare and it is one in which the head of the bone rests in relation with the pubic bone. The limb is slightly shortened, abducted and rotated outward and the head of the bone can be readily palpated in its abnormal position.

The change in length of the limb in these dislocations is determined by the position of the head of the bone whether it is below, above or behind the acetabulum. The degree of eversion and inversion is regulated by the Y-ligament, it holding the trochanter in position while the head is displaced forward and downward, or upward. If the head of the bone is displaced forward and downward, the muscles and Y-ligament hold the trochanter in position thus producing eversion of the foot. If dislocated upward and backward, this ligament holds the trochanter in place and thus prevents eversion. The pain in dislocations of the hip is determined by the amount of damage to the tissues, the degree of inflammation, amount of exudate and the nerves that are impinged upon. Pain is usually present over the sciatic nerve, that is, in its upper part, partly on account of the traction or pressure exerted upon it, or through injury to the pyriformis muscle. Pain in the knee is the result of injury to the obturator or anterior crural nerve. The prominence of the hip is regulated by the position of the trochanter and the condition of the muscles. Ordinarily there is atrophy of the muscles, this producing a depression or flattening of the hip. The two sides should in all cases be compared not only by palpation but by inspection. The various creases of the hip are changed as to depth and direction, particularly the crease formed by the buttocks. The flexion lines just below the buttock are usually obliterated.

Congenital dislocation of the hip is a form in which the acetabulum is so shallow that the hip-bone is forced out of place from pressure during intra-uterine life, or else is forced out of the socket when the child begins to use the limb. The essential point of difference between congenital and acquired forms of dislocation is the degree of development or depth of the socket, that is, it is always shallow in the typical congenital form. The hip is usually displaced upward directly across the rim of the acetabulum, while in the acquired form it is ordinarily displaced downward through the cotyloid notch. In the congenital dislocation there is ordinarily shortening of the limb and the child walks with a rocking movement. Mobility is usually increased rather than restricted and on inspection with the parts exposed, the bone can be seen to play up and down in the muscles, as the child walks. There is no tenderness and the limb can be drawn down almost to the length of the sound side on account of the relaxed condition of the ligaments. Not alone is the acetabulum imperfectly developed but the head of the bone is often mal-developed

on account of interference with its nutrition, while the angle that the neck forms with the shaft is greater than in a normal case. Perhaps the earliest indication of this type of dislocation is that the child does not crawl naturally and is backward in walking. The two buttocks are not the same size, the limb on the affected side is malnourished and the tissues flabby and the child walks with a distinct limp, and if the condition is bi-lateral, the gait is a distinctly waddling one. The diagnosis and prognosis are best made after taking a skiagraph of the hip. The principal involved in the treating of congenital dislocation is to overcome the adductor muscles force the head of the bone into the socket, set up an irritation which would cause an exudate to form, thus holding the head in place and then abducting the limb and putting on a cast, to hold it in this position. The object of this abduction is to place the head of the bone in such a position that the muscles cannot draw it over the poorly developed rim of the acetabulum. In addition to this, passive movement should be begun quite soon after the reduction, that is, the parts should be treated to better the nutrition of the bone, ligaments and muscles concerned.

Articular osteitis of the hip, or hip-joint disease, is a lesion of the joint characterized by inflammation and degeneration of the head of the femur and the acetabulum. It is usually regarded as tubercular in character although, as Hilton points out, it is not necessarily the case. It is associated with traumatism of the hip and sometimes there is a co-existing displacement, that is, the injury causes a lessening of resistance which permits the tubercle bacilli to propagate. About the first indication of this sort of disorder of the hip-joint, is a slight limp. This is more marked in the morning and it gradually wears off as the day advances. This limp is due in part to the stiffening of the muscles and to the inflammation of the joint. **Deformity** soon appears which consists usually of a flexion with abduction and apparent lengthening. This is due to the fact that the child attempts to place the hip in the position of greatest ease. **Atrophy** of the glutei muscles takes place so that the contour is changed, also the gluteal lines are obliterated. **Pain** or tenderness in the hip or in the inner side of the knee, are present in most cases. The child refers the pain to the knee and on pressure the pain is greatest over the head of the bone. The **limitation of motion** is perhaps the best symptom upon which to diagnose this condition. This is the result of contracture of the muscles and change in the form of the bones that

form the joint. The child often cries out in its sleep. The general health is often impaired and the child is pale and anemic and usually has the tubercular diathesis. These symptoms increase in intensity until an abscess forms which usually appears in front of the joint. The disease most frequently starts in the head of the femur and then extends to the acetabulum, and finally there is degeneration of all the parts, unless the progress of the disease is arrested.

In making an examination for this disorder, the child should be stripped of all clothing and caused to walk back and forth in order that the amount of disturbance of function may be the better estimated. If the limp is due to the disease of the hip-joint, the child will not move the articulation very much in making the step. It tries to protect that side by throwing most of the weight on the sound hip. The thigh on the affected side is usually considerably smaller, than on the sound side. By placing the child in the dorsal posture on the table, it will be found that in attempting to force the popliteal space to the table that the lumbar spine will be arched, it being found impossible to force the popliteal space and the lumbar spine to the table at the same time if the case is one of tuberculosis of the hip. By attempted movements of the hip, it will be found that they are limited on the affected side, which is due to the condition of the muscles and ligaments of the hip as much as it is due to the pain. All these passive movements should be given with the greatest care, especially if the disease has reached the stage of pus formation, or if the head of the bone is honey-combed, since **fracture of the neck of the femur may be produced if the parts are handled roughly.**

Partial dislocation of the hip is a condition in which the head of the femur is twisted in the socket, or else drawn up against one side of the acetabulum and held there by muscular and ligamentous contraction. It is usually the result of abduction of the limb in which the movement is carried beyond the physiological range, this throwing the head of the bone against the weak part of the joint. This sort of lesion is more nearly analogous to spinal lesions than are the dislocations of the hip. Partial dislocation is characterized by restriction of movement of the hip, lameness and pain at, and swelling of the knee. This swelling assumes the form of a synovitis of the knee and a puffy enlargement soon forms on the inner side of the joint soon after the injury. The length of the limb may be affected and if it is, it is most frequently slightly lengthened. The toe is often everted and the limb slightly flexed. The measurement

of the hip, that is, Nelaton's and Bryant's lines, do not show any displacement. However, these lines are unreliable even in the diagnosis of a dislocation of the hip. It is a well know fact, clinically, that many cases of lameness characterized by the above symptoms, are due to a twist of the head of the femur in its socket and that the symptoms can be relieved by treatment directed to restoring normal relations between the head of the bone and its socket. The pain in the knee as in other lesions of the hip-joint, is the result of a disturbance of the anterior crural or obturator nerves. The **painful affections** of the hip-joint are the result of dislocation, sprain, caries and certain spinal lesions that affect the sciatic and other nerves that supply the joint, but especially the sciatic. The pain may be a referred one, but this is not so common as in the case of the knee-joint. If it is a referred one, the trouble is most commonly in the pelvic organs, such as an enlargement of the uterus or other viscus which produces pressure directly on the nerve supplying the hip. The **trophic condition** of the hip-joint, especially its degree of development, is controlled by the condition of the lumbar spine. If lesions exist in this area, the nutrition of the hip will suffer, this causing a diseased or shallow socket, weakness of the ligaments of the joint and tendency to tubercular affections. In all trophic and vaso-motor disorders of the hip, the lumbar spine should be carefully examined since a lesion in this region will affect the anterior crural, the obturator, the sciatic and the vaso-motor nerves that supply the hip-joint. These vaso-motor nerves reach the joint by way of the arteries and are derived from the gangliated cord. In all tubercular affections of the hip-joint, this part of the spine should be especially treated, since by so doing the vitality of the hip is increased.

THE KNEE-JOINT.

The **knee-joint** is formed by the lower end of the femur, the upper end of the tibia and by the patella, and is described as consisting of three articulations: one between each of the condyles of the femur and the tuberosity of the tibia and one between the femur and the patella. It is a very large, complicated joint and the surfaces are nearly flat. It is classed as a ginglymoid or hinge-joint, but it is not so typical as is the elbow, since it is much more complicated. On account of the size and shape, it is regarded as one of the weakest joints in the body, but the number, size and arrangement of its ligaments, and the strong muscles

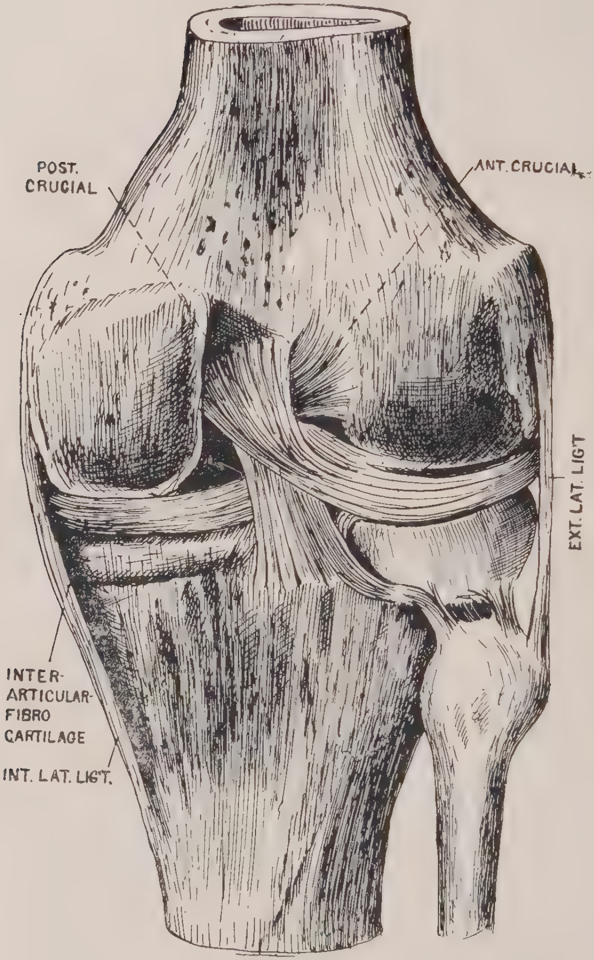

FIG. 144.—The ligaments of the back of the knee-joint.

with their tendinous expansions around the joint, make it quite strong.

There are many ligaments around this joint but only a few will be considered here, namely, the patellar and the semi-lunar cartilages.

The **ligamentum patellæ** or anterior ligament, is the lower end of the quadriceps extensor tendon. It is very strong, broad and flat. It is of interest principally in that fracture of the patella results from the

sudden and strong contraction of the quadriceps extensor muscle. This also has to do with the dislocation of the patella, which condition is not unusual.

The **semi-lunar cartilages** are two crescent-shaped cartilages placed on the top of the tibia. They are wedge-shaped and thus deepen the cavity. They are of interest in that they are subject to displacement which results in the locking of the joint. The knee-joint has a very large **synovial** membrane which lines the surfaces of the bone except those covered by the articular cartilage. It also covers the semi-lunar fibro-cartilages and extends upward several inches under the quadriceps extensor muscle and laterally to the vasti muscles and is separated from the patella by a cushion of fat. It is reflected from the patella and thus forms some of the internal ligaments of the joint. It also assists in forming some of the bursæ in relation to the tendons of the knee-joint. On account of some of these communicating with the cavity of the joint, care should be taken in the opening of them when they are distended with fluid. On account of the extension upward of this synovial membrane, synovitis of the knee is characterized by considerable swelling above the patella, and often the patella itself is lifted away from the lower end of the femur.

The **arteries** of the knee-joint are derived from the anastomotica magna of the femoral, an articular branch from the popliteal and the recurrent from the anterior tibial. The **nerve** supply is derived from the popliteal, anterior crural and obturator nerves. The importance of this is brought out best in cases of dislocation or disease of the hip.

The **movements** of the joint consist principally of flexion and extension and some internal and external rotation. Flexion is limited by contact of the leg and femur. In slight flexion of the leg, all the ligaments are relaxed, with the exception of the ligamentum patellæ, and on this account in injuries of the knee, the limb assumes a semi-flexed position. The posterior crural and common ligaments, prevent over extension, hence are injured in all cases in which the knee is forcibly bent backward. The anterior and posterior crucial ligaments when normal, prevent the bones from slipping forward or backward, while the lateral, prevent lateral displacements. The movements of the knee are restricted by disorders of these ligaments of the synovial membranes and changes of the bone itself. The knee-joint is seldom displaced on account of the number and size of the ligaments surrounding it, but **sprains**

of it are not rare and do not readily yield to treatment. The number of ligaments involved and the extent of the injury, account for this. When force is applied to the joint, the effect is in the ligament rather than the articular surfaces and a **sprain** is the result. In **dislocation** of the knee-joint, there will be prominence on the side to which it is displaced

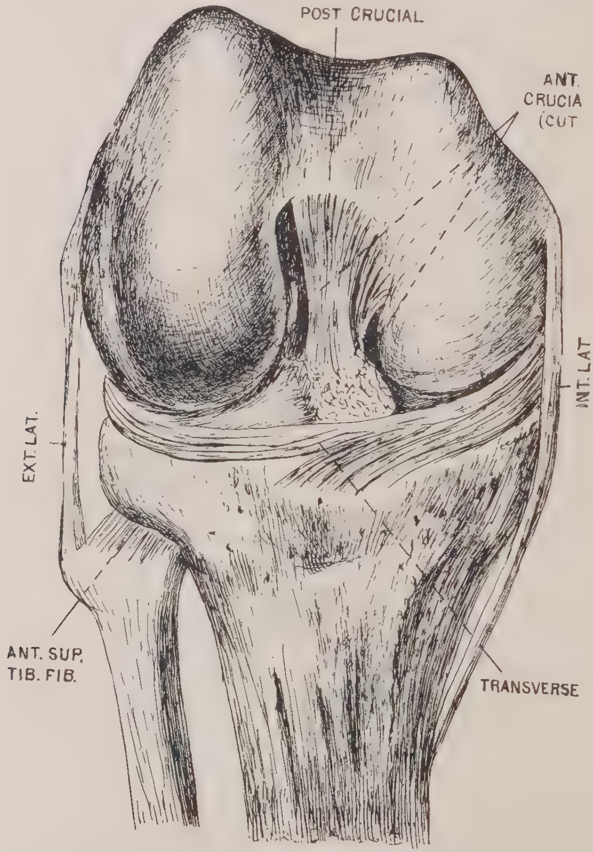

FIG. 145.—Showing the inferior articular surface of the tibia, and ligaments. Note the size and shape of the articular surfaces.

while a depression exists on the opposite side. In recent cases there will be swelling and congestion of the joint. Movement is impaired and painful. It is differentiated from a sprain by the change in contour of

the bones forming the joint since in sprains, change in contour is due to the thickening of the ligaments and the effusion around the joint.

The **patella** quite frequently becomes displaced; the outward dislocation being the most common. It is the result of muscular action or trauma applied to the edge of the bone. The contraction of the quadriceps extensor is the principal cause. The partial form of dislocation of the patella, it is due to relaxation of the ligamentum patellæ. When this condition exists, the patella has too great a play and then from muscular action, it will suddenly slip over one or the other of the condyles, thus causing a **locking of the knee-joint.** Ordinarily the patient can press the bone into place and it causes no further trouble until it becomes displaced a second time.

The **dislocation** of one or a part of the **semi-lunar** cartilage is, perhaps, the most important of all these displacements. The condition is the result of a sudden twist or wrench of the knee, especially during partial flexion. This accident is accompanied by a locking of the joint, severe and sudden pain, swelling and the formation of a prominence on the side to which the cartilage is displaced. One displacement predisposes to another so that the cartilage may slip out on the least strain of the joint. This condition can best be reduced by grasping the cartilage and exerting pressure on it, while the limb is moved to-and-fro. If the fractured cartilage becomes loosened, it may lock the joint at almost any time. The patient may be walking along with no impairment when all of a sudden, the floating piece of cartilage works into the joint and suddenly locks it.

Swelling of the knee is suggestive of a synovitis or an effusion from injury to one of the bursæ. If the patella is raised, or if it floats, in which case it is termed "riding of the patella," it is due to synovitis. If it is not raised by the effusion, it is in the bursa. Most cases of swelling of the knee are due to effusions, which, in quite a number of cases, are due to disorder of the hip-joint. This consists of a slight puffiness on the inner aspect of the knee, which fluctuates in size and is not particularly painful. In other cases, it is due to a sprain of the joint or to over exertion.

In some cases, the enlargement of the knee is due to tuberculosis of the bone, either the lower end of the femur or the upper end of the tibia, in which it becomes honey-combed. Usually an abscess forms in such cases. This breaks above on the inner side of the knee-cap or below and to the inner side of the joint.

Stiffness of the knee-joint may be due to deposits, synovitis, dislocation or to tenderness due to a sprain. The particular form of stiffness can be diagnosed by noting the contour, degree and form of movement and by getting a history of the case. **Pain of the knee-joint** is

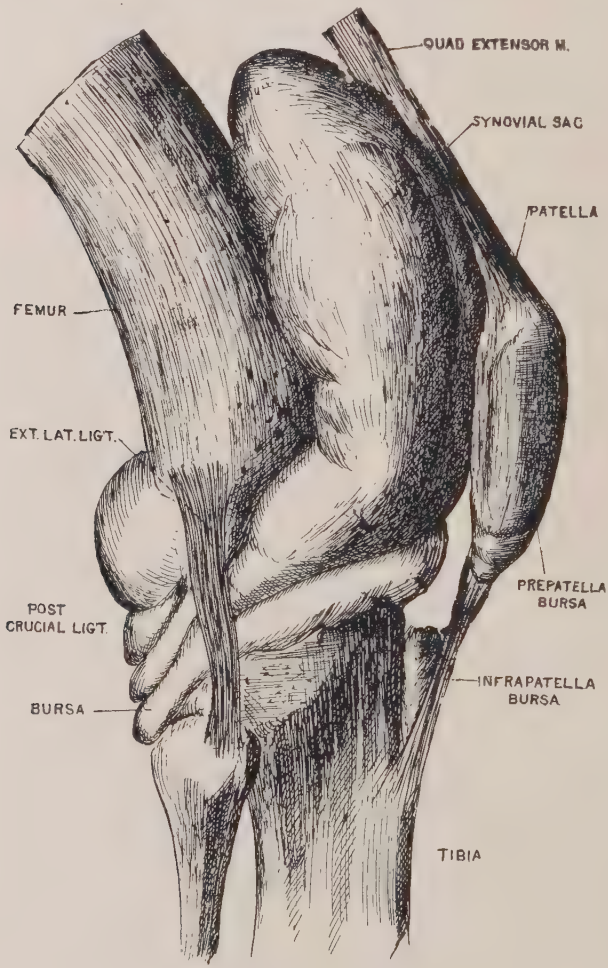

FIG. 146.—The right knee-joint from the lateral surface. (The joint cavity and several bursæ have been injected with a stiffening medium and then dissected out. (After Spalteholz).

usually the result of hip-joint disease, or some form of dislocation of the hip. In other cases it is due to direct injury of the knee, as in sprains, dislocations and synovitis. Crepitus in the knee-joint is very common but usually causes no trouble further than a creaky sound whenever the joint is moved. It is usually the result of an old synovitis in which there were adhesions formed, or it may be the result of fever, over use of the joint or other conditions in which the synovial membrane becomes affected. There is a lessened amount of secretion of synovia, hence insufficient lubrication of the joint and particularly that part between the patella and the femur. Sometimes a portion of the cartilage gets into the knee-joint, or perhaps some foreign body gets into it, which conditions cause a locking of the joint. Little can be done with such a condition.

A lesion of the **tibio-fibular** articulation is sometimes present, a partial dislocation of the fibula being the most frequent of the pathological conditions. Normal movements of this joint are slight, consisting of a slight up-and-down gliding movement. Sometimes the fibula is forced upward and outward, this not only producing interference with the movement, but affecting the external popliteal nerve, which is in relation. In addition to the tenderness at the joint, there is usually irregularity, and if both are found the diagnosis is fairly conclusive. The principal effects of this lesion are pain along the course of the musculo-cutaneous and anterior tibial nerves, and a burning sensation at the bottom of the foot.

THE ANKLE-JOINT.

The **ankle-joint** is formed by the lower ends of the tibia and fibula and the astragulus. The **movements** of this joint are extension and flexion, which combined reach about seventy degrees. The ligaments of the joint and the tendo Achillis, restrict these movements. The ligaments in the front of the joint are weakest of all and on this account, swelling from injury of the joint occurs first at this point.

The most common lesion of the joint is a **sprain** which consists of a rupture to a greater or lesser extent, of these ligaments. In all sprains there is a partial dislocation of the bones forming the joint. On this account manipulation, by which this partial dislocation is reduced, is to be advised immediately after the accident. As a result of this injury there is pain, swelling and inflammation of the parts, particularly the

synovial membrane and ligaments. The effects of this lesion are restriction of movement, swelling and pain. The disturbance of movement is the result of the effect on the ligament and of the change in position of

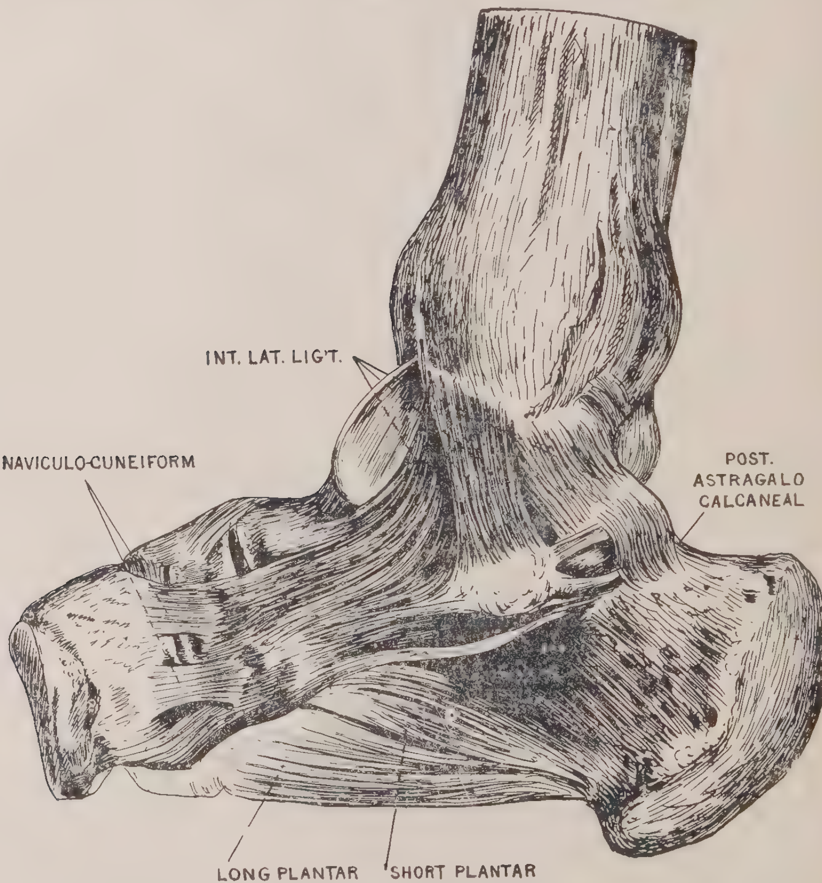

Fig. 147.—The ligaments of the ankle and a part of the foot. The internal lateral are involved in sprains of the ankle-joint.

the bones forming the joint. The pain is due to the rupture of, or pressure on, the nerves in relation.

In Pott's fracture, dislocation quite frequently occurs at this joint, or at least there is a partial dislocation and a sprain which tend to con-

FIG. 148.—The joints of the right foot.

fuse the diagnosis. In elderly people, a fracture should be suspected in cases of injury to this joint and the examination made accordingly. Sometimes the **astragulus** is displaced on its articulations above and below.

The other bones of the ankle and foot are occasionally displaced. The first metatarsal bone and the first phalanx are quite frequently displaced in cases of bunions. In displacements of these small bones of the foot, there will be pain and disturbance of movement. In one case seen by the writer, there was a displacement of one of the cuneiform bones that gave rise to symptoms which simulated hip-joint disease, at least it was so diagnosed by some physicians. There was a limp and pain at the bottom of the foot. In most cases, pain in this area is due to a lesion higher up, but occasionally it is the result of a local lesion. In many cases of pain in the bottom of the foot, it is due to the displacement of a **sesamoid** bone. These bones are formed in the flexor tendons and reach a remarkable size in some instances. In forcible contraction of the muscles of the foot these bones may be forced out of their grooves or articular facets and thus give rise to considerable pain on movement of the foot. Such disorders can usually be diagnosed by palpating the irregularity and noting the location of the pain.

THE LOWER EXTREMITY AS A REGION.

The **skin** of this region is thickened at points of pressure as in front of the knee and the gluteal region. On the inner sides of the knee and leg it is quite thin and very freely movable. The mobility of the skin over these parts tends to protect the joint in cuts and contusions in that the force is directed away from the underlying parts.

The **femoral artery** and **vein** correspond to a line drawn from a point about midway between the anterior superior spine and the symphysis, to the internal condyle. The **popliteal artery** lies in the popliteal space and is subject to pressure at this point in sitting with the legs hanging. The **posterior tibial** artery corresponds to a line drawn from the center of the lower part of the popliteal space to a point just behind the internal malleolus. The **perineal artery** lies behind the fibula and is possibly affected by subluxations and fractures of this bone.

The **long saphenous vein** corresponds to a line drawn from the internal malleolus along the inner aspect of the leg and thigh to Scarpa's triangle. The **short saphenous vein** corresponds to a line drawn from the outer

side of the tendon of Achilles, to a point immediately behind the knee.

The **great sciatic nerve** corresponds to a line drawn from a point midway between the tuberosity of the ischium and the great trochanter, along the back part of the thigh to the center of the popliteal space, at which place it usually divides. The **peroneal** nerve extends from this point down the leg in company with the peroneal artery. The **anterior tibial** corresponds to a line drawn from near the head of the fibula diagonally across to a point about an inch anterior to the external malleolus.

The **bony prominences** which serve as landmarks for the lower extremity also have to do with the **contour** of the part. The **great trochanter** forms a prominence on the side of the upper part of the thigh and is of importance in locating the head of the femur. The **patella** is the principal eminence of the knee. The "shin bone," or the anterior edge of the tibia, determines the contour of this part of the leg and is subject to injuries and fractures. A blow at this place is particularly painful on account of its nearness to the integument, hence has no soft parts to protect it. The **malleoli** are the great landmarks of the ankle, and from them measurements are taken for determining certain forms of injuries of the lower extremity, such as fractures and dislocations.

The **glutei muscles** determine the contour of the hip. The **vasti** and **recti** determine the contour of the anterior part of the thigh. The course of the **sartorius** muscle is brought into prominence whenever the thigh is flexed and adducted. The **hamstring** tendons have to do with the contour of the back part of the knee, while on the inner side, those of the sartorius and vasti and pectineus can be palpated. The **calf** muscles, that is the soleus and gastrocnemius, determine the contour of the back of the leg.

The **changes of contour** of the lower extremity should be carefully noted in making up a physical diagnosis, since nearly if not all disorders of the lower extremities are characterized by some change of contour. Of the **hip** and **thigh**, a dislocation of the femur is the most common cause of change of contour. The change is brought about from displacement of the trochanter, contracture of some muscles and atrophy of others. In all cases in which the contour is abnormal, the diseased side should be compared by inspection, with the sound side. **Hip-joint** disease will also change the contour of the hip, principally on account of atrophy of the glutei muscles. The trochanter in these cases may be also displaced or the neck destroyed, this altering the contour. **Fracture** of the

femur will change the contour of that part on account of change in the bone and the effect on muscles attached. Fracture of the neck of the femur often results in an upward displacement of the trochanter which may be mistaken for a dislocation of the hip. **In all such cases in the aged, an intracapsular fracture of the hip should be suspected.** Change of form of this part results from atrophy or hypertrophy of the muscles or from edema of the thigh. In athletes, often the rectus muscle is ruptured, this causing some change in contour. In the various spinal cord diseases in which the lower limbs are involved, there is a change of contour from atrophy or occasionally from hypertrophy of the muscles of the thigh. Change of contour of the knee and leg is more common than in the thigh.

It is important to understand the surface anatomy of the knee, since there are so many changes of contour of the part. McClellan says: "A knowledge of the construction of the joint may serve to interpret many symptoms and to explain the production of various movements, but what has been aptly called the language of form appeals to the judgment and, if properly applied, often determines the diagnosis and the result of treatment." Synovitis of the knee invariably produces enlargement which is most marked on the anterior and inner aspect. There may be an effusion into the different bursæ around the joint, this producing a unilateral enlargement. Most of these enlargements due to effusion are the result of disorder of the hip-joint, but in some instances they are due to direct injury of the knee. **Tuberculosis** of the knee-joint produces an enlargement, hence change in contour. The upper end of the tibia is most frequently involved and often the bone becomes honey-combed and doubled in size. In cases of **emaciation,** the knee-joints are often apparently enlarged on account of atrophy and shrinkage of the muscles above and below it. **Paralysis** of the leg leads to atrophy, hence change in form. In **neuritis** and progressive muscular atrophy, the calf muscles are more or less atrophied. In **diseases** of the **hip,** such as fractures, dislocations or hip-joint disease, the muscles of the leg are atrophied, partly from non-use and partly, from an interference with nutrition. Fractures of the tibia or fibula change the contour of the leg, Pott's fracture being the most typical. **Edema** of the leg is suggestive of **heart or kidney disease** if symmetrical, but if of only one leg, is suggestive of a spinal or innominate lesion..which interferes with the lymphatic circulation from the limb. Usually the edema is worse to-

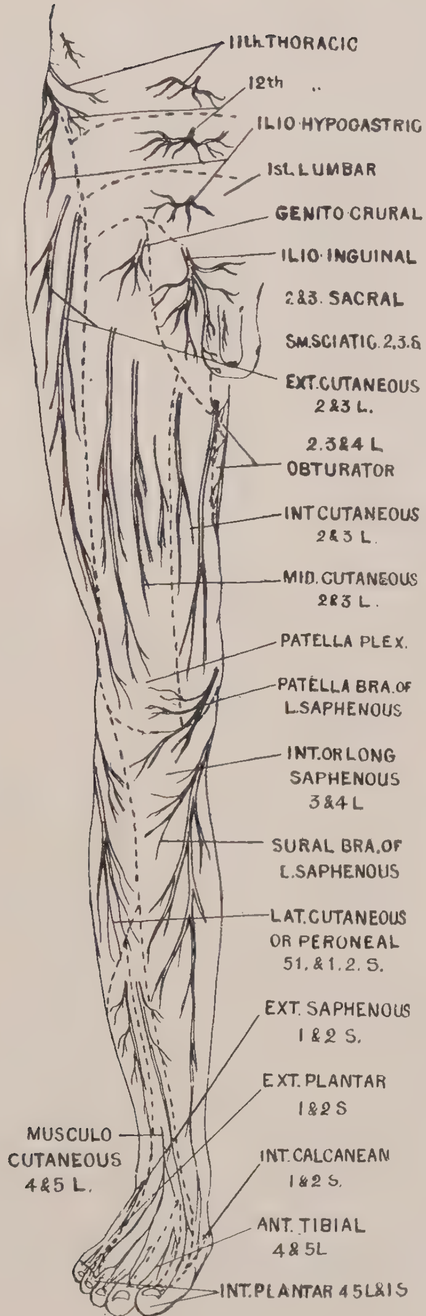

Fig. 149.—The segmental sensory innervation of the lower extremity.

ward evening and especially so, if the patient is on the feet very much. In chronic cases the swelling pits on pressure and if there is an injury to the part, it heals slowly. Edema may be the result of milk-leg which in turn is, I believe, a sequel to innominate lesions which occur during child-birth, although it is popularly believed to be due to infection. The edema may also be a sequel to typhoid fever especially if on the right side. If the entire lower extremity and the external genitalia are involved it is called **elephantiasis.** In most of these disorders of the leg characterized by edema, the trouble is either in the hip-joint or else there is a subluxation of the innominate. Ordinarily if there is no discoloration the trouble is due to lymphatic obstruction, but if the veins are involved, there is in all probability some discoloration.

Rheumatoid arthritis often produces a change in contour of the knees and feet on account of the deposit around the joints. There are certain nervous disorders called **arthropathies,** which produce enlargement of the joints, particularly those of the lower limb.

A **sprain** of the ankle may result in a deformity which may last for months on account of the edema and swelling of the injured ligaments. In those chronic cases a dislocation or fracture should be thought of. If it occurs in an aged person or one who is mal-nourished, it is possibly a fracture, but in the young a dislocation is more common than a fracture.

The **arch** of the foot may be broken down, this producing a condition called "flat foot." This weakens the ankle and leads to a peculiar gait. The various forms of talipes, result from contracture of tendons, alteration in the shape of the bones, partial displacements and from shortening of ligaments and fascia attached to the foot. If the patient walks on the toes, which condition is called **talipes equinus,** it is generally the result of infantile paralysis, the deformity being the result of a contraction of the tendo Achillis. **Talipes varus** is the most common of the congenital forms on account of the attitude of the fetus in utero. In the acquired form the os calcis is drawn up by the tendon of Achilles thus partially displacing the astragulus. **Talipes valgus,** or flat foot is the result of breaking down of the arch and occurs in those who are underfed and in people who have to stand on their feet a great deal. It occurs in some cases of improperly cared for Pott's fracture. In these various deformities of the foot, the tendinous contractures are prominent and sometimes they reach such a degree that tenotomy has to be performed before the deformity can be overcome.

The various **movements** of the limbs, that is the gait of a patient, are very suggestive of the disease with which the patient is afflicted. Although the **gait** varies in normal individuals, yet ordinarily the appearance of the legs and feet and the peculiarity of the gait, reveal the fact that there is something wrong with the movements of the limb. If the patient has a "heel and toe" walk and has to look where he steps, and if the arch of the foot is flattened, it is quite suggestive of locomotor ataxia. This disturbance of movement is due to an impairment of the muscular sense more than to a weakness of the muscles. There is also some weakening of the ankle and the patient is unable to stand on his heels although the muscles of the lower extremities seem to be in a thoroughly good condition. In multiple neuritis, there is a peculiar gait called the "steppage" gait. (The foot is drawn forward and the toe is raised so that the heel first strikes the ground in much the manner adopted when one attempts to step over an obstacle). In **spastic paraplegia**, the toes seem glued to the floor and the patient has to lean forward in order to be able to advance the limbs. This gait is explained by the fact that the flexors of the thigh are weakened, while the flexors of the leg are shortened. The toes are inverted, the knees adducted and the patient has what is commonly called a **"cross legged progression."**

In **atonic paraplegia,** both feet are dragged, the toes trailing on the ground. The patient necessarily has to walk with crutches and the limbs are dragged along. In **infantile paralysis** in which one limb is involved, the foot is usually everted and the patient drags it in such a fashion that the inner side scrapes the floor. **Hemiplegia** is characterized by a dragging of the foot on the paralyzed side in such a way that the end of the toe and inner side of the sole is worn. This coupled with paralysis of the upper extremity on the same side makes the diagnosis clear. This peculiarity of gait is the result of weakness, that is, inability to advance the limb, hence it is dragged. In children a "waddling gait" is suggestive of a double displacement of the hip. It is present in congenital dislocation of one hip but less marked. In iliac displacements of the hip, the toe is turned in and the limb shortened, the body is inclined toward the affected side. In a thyroid displacement of the hip, the toe is turned outward and the limb is lengthened and the patient's body is inclined to the opposite side in order to tilt the pelvis so that the limb may be shortened. A **propulsive gait** is indicative of paralysis agitans. A **drunken gait** occurs in patients suffering with cerebellar ataxia and in

certain forms of chorea. In cerebellar ataxia there is the intentional tremor. The patient may, in reaching for an article, stab all around it and finally gets his hands on it in a manner similar to that of a drunken person. A **stiff gait** is often found in disseminated sclerosis, this closely resembling the gait of spastic paraplegia. In Friedreich's ataxia the gait is uncertain and if the patient is told to stand with his feet together there will be swaying of the body. This is due to inco-ordination and loss of muscular sense.

The various **limps** are due to painful conditions of the hip, knee or foot, or possibly of the spine. By examination, the cause is usually very easily ascertained, and by knowing the different forms of disorder of the gait and movements of the limbs, the cause can more easily be located.

Pain in the hip-joint is suggestive of displacement, caries, sciatica, or lesions of the various bones with which the sensory nerves to this part are in relation. **Pain in the knee-joint** comes most frequently from partial displacement of the hip, or other disorder of this joint. It may be due to a synovitis of the knee, a loose cartilage, or a displacement of the bones forming the joint. **Ache** or pain along the **femur,** comes most frequently from an inflammation or congestion of the sciatic nerve. This, in turn, comes from pelvic disorders, spinal cord diseases or a lesion of the spine or innominate bones. **Pain in the leg** is the result of pressure on the nerve supply at some point or it may be referred from visceral disease such as inflammation of the pelvic organs. **Pain** in the **foot** may be the result of the displacing of any of the joints with which the sciatic nerve or its branches are in relation, or it also may be the result of a visceral disorder from which the pain is referred.

In most painful disturbances of the leg not due to inflammation or trauma, there is some lesion of the joints in relation with the sciatic nerve which has most to do with supplying sensation to the lower limbs. It is a good plan to examine first the joints in relation with the pain and then successively all the joints between the point of pain and the spinal cord. Perversion of sensation, such as **numbness** or tingling of the nerves of the lower extremity, is most frequently due to pressure on the trunk of the nerve. This is illustrated by the fact that by sitting on a high chair and suspending the legs, they will go to sleep. Numbness may also be due to cerebral disorders. In all these affections the spinal column should be examined, since a lesion of any of the lumbar vertebræ will in all likelihood, intercept the passing of sensory impulses

from the lower extremity to the spinal cord, thus the perversion of sensation.

The most common vascular disorder of the lower limb is a **varicosity** of some of the superficial veins. The vein most frequently affected is the **long saphenous** and especially that part in relation with the ankle. The superficial veins are affected because their walls are not reinforced by muscular contraction, and the part farthest away from the heart and subject to greatest pressure would be affected most, hence the varicosities are found on the inner side of the ankle. The vaso-motor centers for the lower limbs are located in the lumbar spinal cord. The impulses from these centers pass out over the nervi efferentes into the aortic plexus, thence along the plexuses around the arteries which go to the lower limbs. This line of communication between the spinal cord and the gangliated cord and the various vessels of the lower extremities, must be kept open or else there will be some effect in the parts supplied. A lesion of the lumbar vertebral articulations, will in some way interfere with this communication, because the displaced bone produces pressure on the nerves over which these impulses pass. On this account in all vascular disorders of the lower extremity such as congestion, inflammation, varicosity or coldness, the spinal column should be examined. In other cases, a dislocated hip or diseased condition of the pelvic viscera will produce vascular disorders of the lower limb. All the blood from the limb passes up through the pelvis and any pelvic enlargement would tend to interfere with the drainage of the limb. In fibroid tumors, congestive hypertrophy of the uterus and in pregnancy, the lower limb is affected as to its circulation. The trophic impulses seem to go hand in hand with the vaso-motor. In non-development of the acetabulum, lack of development of the femur, or other bones of the lower extremity, in atrophic conditions of the limb or even in caries, the spinal column should be examined since lesions of the lumbar portion, interfere with the passing of vaso-motor and trophic impulses from the spinal cord to the parts below.

In tuberculosis of the hip and knee, the principal treatment is directed to improve the nutrition of the part. This is accomplished by spinal treatment, in addition to the constitutional. Therefore in trophic and vascular disorders of the lower extremity, examine especially the lumbar vertebræ, innominate bones and the hip-joint. The **secretory** disorders of the lower extremity consist of excessive or lessened perspira-

tion. **Sweating of the feet** is the most common. In some cases this perspiration is markedly acid and the writer has known of cases in which the patient would rot out a pair of shoes in a month or so as the result of this disturbance of the secretion of sweat. This may be the result of a constitutional disorder, yet in some cases, at least, it is due to affections of the sweat centers on account of lesions in the lower thoracic and lumbar area. Dryness of the lower extremities is more suggestive of kidney disorder than of anything else. However, if it is a local one, the cause is along the course of the nerves that have to do with connecting the sweat centers with the periphery.

THE CRANIAL NERVES.

THE OLFACTORY.

The **olfactory nerves** consist of roots, tract, bulb and about twenty fine non-medullated nerve fibers that are distributed to the mucous membrane of the nasal cavity. This nerve is the special nerve of smell and is stimulated by volatile, odorous substances. It acts as a sentinel to warn the body against bad air and the ingestion of improper foods. The stimulation of this nerve seems to reflexly affect the secretion of saliva. On this account food that has a pleasant odor is more palatable and more easily digested than that which has an unpleasant odor.

This nerve is seldom affected directly, but may be disturbed through fracture of the cribiform plate or tumors of the brain. In most cases of disorders of the sense of smell, anosmia being the most important, the fifth cranial nerve is involved and consequently there is a lessened or hyper-secretion of mucous from the membrane lining the cavity. Lesions of the cervical articulations, especially those of the axis and the third, and of the upper thoracic vertebræ, disturb the functions of this nerve by affecting the fifth cranial and the vaso-motor nerves supplying the nasal mucous membrane. The explanation is that the lesion affects the vaso-motor nerves at their origin or along their pathway and thus interferes with the circulation through the mucous membrane lining the nasal cavity, that is, it produces a catarrhal condition of the nose. In other cases the turbinated bones become diseased or polypi form in the nose. These disorders affect the sense of smell by interfering with the normal secretions rather than by directly affecting the olfactory nerve, In hysterical individuals there may be hyperosmia, while in epileptics, aura often start in the nose.

THE OPTIC NERVE.

The **optic nerve** rises from the quadrigeminal body and the optic thalamus and is connected with the occipital lobe. The two tracts converge to form the optic chiasma or commissure, from which the optic nerves are formed. The nerve is directed forward and outward, pierces the dura mater and escapes from the cranial cavity through the optic foramen and it spreads out to form the principal part of the retina. It is in relation with the ophthalmic artery and is pierced by the **central artery of the retina.**

The **function** of the nerve is that of vision. This function may be disturbed by disorders of the blood, pressure from hemorrhage or intracranial tumors, fractures of the skull and in certain spinal cord diseases and spinal lesions. The most common lesions affecting the optic nerve are in the upper cervical and upper dorsal regions. These lesions disturb the circulation and nutrition of the nerve since the vaso-motor centers for the ophthalmic artery are as low as the third thoracic segment of the spinal cord. The impulses pass out over the anterior nerve roots into the gangliated cord, thence upward and into the superior cervical ganglion. Then they are conveyed by the cavernous plexus directly to the optic nerve with the central artery of the retina. It is a clinic fact that spinal injuries produce atrophy of the optic nerve. Writers on the subject do not agree as to the explanation of this effect, some leaning to the view that they are the result of a trophic disturbance, while others assume that they result from an ascending meningitis, while others contend that these injuries produce a fracture of the base of the brain. From an osteopathic viewpoint, the effect, that is, that of optic atrophy, is explained on the theory of vaso-motor disturbance which is the result of spinal injury, in cases in which the injury is above the fourth thoracic vertebra. Gifford, in the American Text-Book of Diseases of the Eye, states "that the numberless cases of optic nerve atrophy in various forms of spinal disease also led to the belief at one time prevalent, of a trophic connection between the spinal column and the optic nerve; and because the disc in many of these cases (though by no means in all) was of a grayish hue, it was common to speak of gray or spinal atrophy. The spinal affection in which atrophy is most commonly observed is tabes." The explanation of this connection as given is that the **vaso-motor** and possibly the **trophic** impulses to the optic nerve,

arise as low in the spinal cord as the third thoracic segment. Spinal cord diseases or lesions of the vertebral articulations at or above this point will affect the function of the optic nerve.

In **kidney disorders** particularly the interstitial form of nephritis, the optic nerve is usually affected, thus producing some form of blindness. In **artero-sclerosis**, the central artery of the retina or the opthalmic artery, may be involved and consequently disturbance of function of the optic nerve occurs. In the condition known as "choked disc," there is usually present a **brain tumor** producing pressure on the chiasma. The nature of this condition is not well understood, but according to some it is due to the cerebro-spinal fluid, under increased pressure, forcing its way into the optic sheath and so compressing the veins as to produce a true congestion or edema, which may be accompanied by inflammation.

Most of the causes of disorders of the optic nerve are **extra-cranial** and are especially found in the upper part of the neck and back. They produce disturbances of the nerve principally through vaso-motor affects on the brain, such as congestion, tumefactions and malnutrition of the centers of vision or the optic tract.

The **blood supply** for the center of vision, that is, the central lobe, comes principally from the vertebral artery. Possibly the best explanation of the connection existing between the lesion and the optic nerve is through the disturbance of the vertebral artery and plexus.

THE THIRD.

The **third cranial** nerve has its origin in the gray matter underneath the fissure of Sylvius. Brubaker says that this nerve "consists of about fifteen thousand peripherally coursing nerve fibers which serve to bring the nerve cells from which they arise into relation with a large portion of the general musculature of the eye." It passes through the cavernous sinus and enters the orbit through the sphenoidal fissure. As it enters the orbit it divides into **two branches,** the **superior** and **inferior,** the superior supplying the superior rectus and the levator palpebræ superioris muscles, while the inferior supplies the internal and inferior recti and ends in the inferior oblique muscle. This nerve communicates with the cavernous plexus, the ophthalmic division of the fifth and sends a branch to the ciliary ganglion which is called its motor or short root.

The **function** of this nerve is to transmit nerve impulses to all the muscles of the eye except the external rectus and the superior oblique. As the result of a lesion paralyzing or inhibiting the action of this nerve, there will be ptosis, strabismus, double vision, some dilatation of the pupil, loss of power of accommodation and sometimes vertigo and photophobia. These effects may be produced by intra-cranial disorders, such as cerebral tumors or hemorrhage, or by extra-cranial affections, such as lesions in the upper cervical region. It is a well known fact that lesions of the upper cervical vertebræ will produce disturbance of the third nerve. The writer has seen and treated cases of this sort in which there was no doubt but that the lesion produced the effect, ptosis being the most common and pronounced. It is difficult to explain why such a lesion will affect the third cranial nerve, unless we do it through the vaso-motor connections. So far as we can ascertain from the literature, writers in general, claim that no motor impulses from the spinal cord pass upward into this nerve, but one author states that some pass from the medulla upward into it and are distributed to parts supplied by the nerve.

Vaso-motor impulses for the vessels which supply the part of the brain from which this nerve arises, apparently come from the upper thoracic area and pass by way of the gangliated cord and its branches around the carotid artery through to the blood-vessels of this part of the brain. This is disputed by some, but it appears to be the most reasonable explanation of the relation between the cause and effect. The lesion interferes with the nutrition of the cells, or perhaps the nerve itself, since nutrition is governed to a great extent, by the vaso-motor nerves.

The **lesions** that are most commonly found in affections of the third cranial nerve are: subluxations of the second and third cervical vertebræ. These act as predisposing causes, while the exciting causes that are usually given, act the more readily. If the effect on the nerve appears to be the result of intra-cranial disorder, such as a hemorrhage, the cause of this is extra-cranial, that is, in the neck. The condition of the cranial viscera is controlled by the spinal cord and therefore the communication between the two parts should be free.

THE FOURTH.

The **trochlear** or patheticus nerve arises below the grey matter surrounding the aqueduct of Sylvius. It has a long course before it makes its exit from the cranial cavity and is distributed to the **superior oblique** muscle. It receives a branch from the cavernous plexus and from the ophthalmic division of the fifth nerve. The sympathetic carries to it vaso-motor fibers, while the fifth cranial, gives to it the muscle sense fibers. It is motor and trophic in function. In cases in which this nerve is involved often the patient holds one side of the head slightly elevated. Lesions of the neck may affect this nerve through the vaso-motor connections. The disturbances of it are rare.

THE FIFTH.

The **fifth cranial** nerve is similar to a spinal nerve in that it arises from two roots, a motor and a sensory, and has a ganglion. The **motor** root is derived from the floor of the fourth ventricle. The large **sensory** posterior root, according to Landois, receives fibers "(1) from the gray matter of the sensory nucleus of the trigeminus, situated to the side of the motor nucleus, and the analogue of the posterior horn. (2) From the gray matter of the posterior horn of the spinal cord down to the second cervical vertebra. (3) From the cerebellum, fibers passing through the crus." The origin of the sensory root, is connected with the motor nuclei of all of the nerves arising in the medulla oblongata, with the exception of the abducent. This fact explains the various reflex effects.

The trigeminus divides into three principal divisions, the **ophthalmic, superior** and **inferior maxillary.** These nerves through their ganglia, connect with most of the other cranial nerves. The ophthalmic division communicates with the third, fourth and sixth cranial nerves in the cavernous sinus. Through the spheno-palatine and otic ganglia, the fifth nerve communicates with the seventh cranial nerve, and with the ninth nerve through the otic ganglion. It also has a very free connection with the cavernous and carotid plexuses and receives from them most of its vaso-motor impulses. This nerve is principally sensory in function although it transmits motor, vaso-motor, secretory and trophic impulses. On account of the wide area of distribution and the importance of the parts supplied, as well as the character of the impulses, this nerve is very important and is connected with nearly all diseases of the head and face.

This nerve, like the other cranial nerves, is subject to disturbance from intra-cranial growths, congestion of the head, while it is particularly liable to disturbance from caries of the teeth and various disorders of the nasal cavity, mouth, ear and throat. In addition to these, this nerve is affected by lesions in the cervical and upper dorsal regions and subluxations of the lower jaw. A lesion of a **cervical** vertebral articulation will affect this nerve in one of two ways. First, this lesion will intercept the passage of impulses from the spinal cord to the nerve and second, it will interfere with the nutrition of the descending root of the nerve by pressure on the veins and arteries that drain and supply the segments of the cord in which this root is found. Lesions of the upper thoracic area will affect the fifth cranial nerve by intercepting the passing of vaso-motor and other impulses from the upper thoracic spinal segments into the gangliated cord, or it will interfere with the nutrition of the nerve cells that give rise to the vaso-motor impulses that pass to the head and face and are distributed by means of the fifth nerve. These lesions also interfere with the circulation, that is, nutrition of the fifth nerve and its cells, since they disturb the circulation to the brain. A lesion of the **lower jaw** will affect the nerve by direct pressure or injury, since it sends a filament to the temporo-maxillary articulation. One or all of the functions of the fifth nerve may be affected by these lesions and in our clinic work, it is very common to find the cervical lesion responsible for most of these disturbances.

The fifth cranial nerve is **motor** to the azygos uvula muscle through the posterior palatine nerve, to the tensor palati and tympanum muscles, the digastric, mylo-hyoid and the muscles of mastication, which consist of the temporal, the two pterygoid and the masseter.

The motor impulses for the dilators of the pupil come immediately from the ophthalmic division of the fifth and indirectly from the cervical sympathetic. Although it has not been definitely demonstrated that motor impulses pass from the spinal cord to the head and face, yet it is to be presumed that they do, this presumption being based on clinic results. Cervical and upper thoracic lesions, affect the muscles of the eye, this having been demonstrated in many cases treated by the writer. Assuming that no motor impulses pass from the spinal cord to these muscles, the effects can be explained through the vaso-motor and trophic connections that undoubtedly exist between the spinal cord and parts supplied with motor impulses by way of the fifth cranial. These im-

pulses arise in the upper part of the thoracic spinal cord and pass by way of the gangliated cord and its ascending branches to the ophthalmic division of the fifth. Lesions along the course of these fibers intercept or otherwise interfere with this connection and consequently there is an effect in the parts supplied.

Landois says: "Anastomotic fibers pass from the second cervical nerve downward through the lateral columns of the spinal cord to the cilio-spinal region and thence through the three or four uppermost thoracic nerves into the cervical sympathetic. .... In the dog and in the cat, at least, these fibers do not pass through the ciliary ganglion, but directly along the optic nerve to the eye, all passing through the Gasserian ganglion, the first division and finally through the long ciliary nerves."

The fifth cranial nerve is **sensory** to nearly all the dura mater, the eye-ball and its appendages, the mucous membrane lining the cavities of the head and face, the integument of the face and side of the head, the teeth, tonsils, two-thirds of the tongue, mastoid cells, the various glands and articulations of the lower jaw. Pain in any of these parts is due to an irritation of this nerve either at its periphery, along its course or in the cranium. Since neither the nerve cells nor the course of the nerve is in relation with the spinal cord, it is somewhat difficult to explain why lesions of the cervical vertebræ affect the sensory function of this nerve. That such lesions do affect the functions of this nerve is a well demonstrated clinic fact. There are two ways of explaining the effects of a cervical lesion on this nerve. First, the long or sensory root comes from as low in the spinal cord as the second or even the third cervical segments, while second, the nerve, and the parts to which it is distributed, receive their trophic and vaso-motor impulses from the spinal cord and these are affected by the lesion, since they come from the spinal cord. Pain is defined by Baruch as "the prayer of the nerve for pure blood." There may be anemia of the nerve or other vascular disturbances, in which there is either abnormal pressure on, as in contracture of muscles or stimulation of the nerve filament, from the toxic products of the stagnated blood, which things affect the nutrition of the nerve. These, according to the above definition of pain, produce pain.

The fifth cranial nerve supplies about three-fourths of the dura mater with sensory impulses, the vagus being the other important nerve to this part. In most cases of **headaches** the dura mater is affected

through the disturbance of the fifth nerve. A lesion in the neck will produce headache by causing a congestion of the brain and this in turn produces pressure on the meninges, probably the most sensitive structure in the cranial cavity, hence the ache is actually due to pressure on the branches of the fifth cranial nerve from increased amount of blood in the unyielding cranial cavity. The throbbing type of headache is the result of this pressure being increased with each pulsation of the heart, hence the pain is synchronous with the heart beat. Stooping, increases the blood pressure in the cranial cavity and thus increases the intensity of the ache. Exercise of any sort which causes an increased rate in the heart beat, will cause the pain to become more severe and the throbbing is harder and more frequent. In such a case, exercise increases the heart rate and as a result, the blood pressure in the brain is proportionately increased and since there is a pathological congestion already existing, the increased pressure produces pain in the meninges. In the other types of headache, the fifth cranial nerve is irritated by the toxic material in the blood. This may come from retention of the menses, liver or gastric disorders, kidney disease, cystic degeneration of the ovary and from cervical lesions that impair the quality of the blood circulating through the brain by lessening the rate of flow. So soon as the current slows, the blood deteriorates in quality, and in passive congestion, toxic products are formed which, in turn, stimulate the sensory nerves. The most common lesions that affect the sensory innervation of the dura mater and thus have to do with the production of headache, are at the second and third cervical, fourth, fifth, seventh, eighth and ninth dorsal and the fourth and fifth lumbar, that is, the headache may be due to disturbances of the vaso-motor supply to the brain, affection of the heart, disturbances of the quality of the blood through diseases of the liver and kidneys and reflexly, through diseases of the uterus.

Pain in the eye-ball is the result of some disorder of the fifth cranial nerve which supplies it. This is explained through the vaso-motor and trophic nerves, which receive their impulses from points below, and on account of which a cervical lesion will affect the eye. The aching of the eye-ball is most frequently the result of a congestion of it either from overuse, catching of cold, or neck lesions affecting the vaso-motor supply to it.

Pain in the various cavities lined with mucous membrane, is usually the result of congestion of these mucous membranes, the pain being the

result of pressure on the nerve as a mechanical stimulation, or chemical stimulation, as in the case of toxic matter in the blood.

Pain in the different parts of the face at which points the fifth cranial nerve becomes superficial, is ordinarily the result of **congestion of the nerve itself,** as is demonstrated by the pain on pressure over the supra-orbital nerve when the patient has a cold in the head. **Toothache** is most commonly the result of irritation of the fifth nerve from decay of the tooth. A lesion of the lower jaw may cause the pain to be referred to a tooth that is apparently sound, while a neck lesion may interfere with the nutrition of the nerve, on which account pain will be referred to its area of distribution, that is, the teeth.

The **soft palate,** the **uvula, tonsil, salivary glands** and two-thirds of the **tongue** receive their sensory innervation by way of the fifth cranial, hence, in pain in these areas the fifth nerve is at fault. The trouble m y be a peripheral one, or it may be a referred pain, since it is a well known fact that an irritation of one part of the fifth nerve often produces a pain in another part, which is ordinarily called a sympathetic pain. A good illustration of this is that **a decayed tooth will produce earache.**

Facial neuralgia, one of the most painful affections, is the result of congestion or inflammation of the fifth cranial nerve. This comes most frequently from a neck lesion, which disturbs the vaso-motor supply of the blood-vessels of this nerve. Some palliative effect can be obtained by the application of heat to the affected part or from pressure along the course of the nerve.

The fifth cranial nerve is more closely connected with the sympathetic nervous system than any other cranial nerve, perhaps on account of the numerous ganglia in relation with it. On this account, many visceral disorders cause pain to be referred to the area supplied by the fifth nerve, and particularly the coverings of the brain and the eye. Often in uterine displacements or inflammation, pain is referred to one eye or to other parts supplied by the fifth nerve. In nearly all those cases in which the pain is a referred one, there **are local lesions that disturb the nutrition and circulation of the nerve** and are in the main, responsible for the referred pain. Thus in the various types of reflex headaches, there are ordinarily, lesions of the upper cervical vertebral articulations.

The fifth cranial nerve receives its vaso-motor impulses from the superior cervical ganglion, that is, they pass through this ganglion.

They pass upward over the plexuses around the carotid arteries and through the Gasserian ganglion, thence over the divisions of the nerve and especially the ophthalmic or first division of the nerve. Although parts of the head and face receive their vaso-motor impulses directly from the superior cervical ganglion, yet most of them pass through the fifth nerve.

Nearly, if not all, the **vaso-motor impulses to the blood-vessels of the eye** and its appendages, pass through the **ophthalmic division of the fifth,** the parts to be especially mentioned are the iris, choroid and the retina. Since the vaso-motor impulses to the parts supplied by the cranial nerve are derived from the spinal cord, especially the upper thoracic segments, it is readily seen why lesions of the cervical and upper thoracic vertebræ, would produce vascular disturbances of the above areas.

The **secretory** impulses that pass through to the lachrymal, mucous, salivary and sweat glands, come from the spinal cord by way of the cervical sympathetic and the fifth cranial nerves. The lesions of the cervical region will increase or decrease the secretion of the lachrymal gland. This is explained through either the secretory or vaso-motor nerves, since secretion seems to depend to a great extent, upon the amount and quality of blood. The condition in which there is an excess of secretion, is called the "weeping eye" and in cases seen by the author, there were lesions in the neck that were responsible.

The mucous glands lining the nasal and oral cavities, the throat, and those covering the tongue, receive their secretory impulses from the spinal cord by way of the fifth nerve. As in secretion in other parts of the body, the vaso-motor nerves are to be considered. The best example of a neck lesion producing secretory disturbances of the mucous membrane, is an ordinary **cold.** Invariably in these cases some sort of neck lesion is present such as contracture of muscles, and congestion of the deep tissues, due primarily, in the average case, to subluxations of one or more of the cervical vertebræ. Pressure over the articular processes is productive of pain or at least soreness. Sitting with the back of the neck in a draft will cause these muscular lesions to form and within a few minutes the coryza will develop. The lesions affect in some way, the passing of vaso-motor and secretory impulses to the mucous glands located in the nose and thus the effect.

The **salivary glands** receive their impulses from the upper thoracic

segments of the spinal cord, they passing by way of the cervical sympathetic cord, superior cervical ganglion, cavernous plexus and the maxillary divisions of the fifth nerve. A lesion of any vertebral articulation, at the origin or along the course of these nerve fibers, will stimulate or inhibit the passing of impulses over them, thus an increase or decrease in the amount of saliva secreted. Most, if not all, the secretory nerves of the sweat glands of the head and face come from the spinal cord by way of the cervical sympathetic and the fifth cranial. There may be excessive sweating of the head, dryness of the parts or localized disturbances. The writer has treated cases of **hemidrosis** in which the cause was located at the articulation between the second and third cervical vertebræ. A cure was effected in these cases by the correction of the lesion, which is at least indicative of the fact that secretory impulses pass from some point below in relation with this articulation, and were affected by the lesion.

An oily condition of the skin of the face is most frequently the result of impairment of the sweat, as well as the sebaceous glands. The amount of sweat is lessened, hence the sebaceous secretion is not dissolved, diluted or washed away by the sweat, therefore remains in the pores of the skin. In such cases the affected parts of the face never sweat. The lesion is sometimes found in the neck and is the possible cause of this disorder. There is an increased secretion of sebaceous matter when the patient becomes heated from exertion and the face becomes quite oily but no perspiration is visible. This condition is worst in warm weather.

It is as yet a disputed point as to whether trophic impulses pass over the trigeminus or whether certain effects in parts innervated by the fifth, are not due to vaso-motor disturbances. If the nerve is divided, there will be, within a few days, inflammation and finally necrosis of the eyeball, and trophic disorders of the other parts supplied by the fifth cranial nerve. In such experiments the eye becomes anesthetic and thus is unable to expel dust or any irritant that may get into the eye. The organ is not conscious of an injury and makes no effort to remove the irritant. The reflex secretion of tears is wanting and thus the foreign body remains in the eye and finally sets up an inflammation which is the result of loss of sensation, rather than an interference with the trophic nerves. At any rate there are trophic disorders that are of importance as a result of affections of the fifth cranial nerve. Among these disturb-

ances are falling of the hair, grayness and splitting of the hair, eruption on the face, dryness of the skin and keratitis and other disorders of the eye characterized by malnutrition.

The fifth cranial nerve furnishes to the muscles of the face what is called by Landois **"muscle sense."** In lesions impairing this nerve, the delicacy of movement of the muscles of the face is impaired in consequence of the absence of the muscle sense.

THE SIXTH.

The **abducens nerve** arises from a nucleus with large cells that corresponds to the anterior horns of the spinal cord. This nucleus is located in the floor of the fourth ventricle in relation with the deep origin of the oculo-motor. Landois says: "Probably some oculo-motor fibers arise from the abducens nucleus and from the left, those fibers of the right oculo-motor that rotate the right eye inward. (This explains the synergistic action of the two eyes in lateral movement)." This nerve passes out of the cranial cavity through the sphenoidal fissure and supplies the external rectus muscle. While in the cavernous sinus it receives branches from the cavernous plexus that convey to it vaso-motor impulses and branches from the ophthalmic division of the fifth nerve. The sympathetic communicating branches in all probability, carry motor impulses to the nerve from the spinal cord. Landois says, that in the cat, the motor fibers for the external rectus pass in part through the dorsal nerves, from the first to the fifth. In man, according to Klumpke and Oppenheim, the communicating branch of the first dorsal nerve is the path for the motor impulses to the unstriated muscles of the eye and the external rectus muscle. A lesion at the origin of or along the course of these nerve impulses to the external rectus muscle, will affect the activity of this muscle, hence strabismus. If the lesion is irritative, there will be external strabismus but if it is paralytic, internal strabismus will result. Again, cervical and upper thoracic lesions, disturb the vaso-motor innervation of this nerve which is followed by weakness and a resultant squint. Clinically, these lesions seem to be responsible for the acquired cases of strabismus, while in the congenital form there is some disturbance of the muscle itself such as contracture or shortening. Perhaps the best explanation of why spinal lesions produce disturbances of the abducens nerve is that it, according to Landois, receives motor impulses by way of the cervical sympathetic, and the above mentioned lesions affect the cervical sympathetic nerves.

THE SEVENTH.

The **facial nerve** has its deep origin in the pons under the floor of the fourth ventricle. It is described by Morris as a mixed nerve having a sensory and motor root, the former consisting of the pars intermedia. This intermediate part arises from the medulla in connection with the nucleus of the glosso-pharyngeal, and sends most of its fibers to the facial and the remainder to the auditory. In company with the auditory nerve, the facial enters the internal auditory canal and the aqueduct of Fallopius. It then makes a sharp bend at which is located the geniculate ganglion, which is supposed to be analogous to the ganglion on the posterior nerve roots of the spinal nerves. While in the internal auditory meatus, the seventh, gives filaments to the eighth nerve, the auditory artery and perhaps the temporal bone. It gives off along its course, the great superficial petrosal, the chorda tympani, motor nerve to the stapedius muscle, branch of communication to the small superficial petrosal nerve, a filament to the vagus and the external superficial petrosal, which connects the geniculate ganglion with the sympathetic plexus surrounding the middle meningeal artery. After it escapes from the skull through the mastoid foramen, it divides into the posterior auricular, lingual, muscular to the posterior belly of the digastric and the stylo-hyoid. In the substance of the parotid gland it divides into the two terminal divisions, the temporo-facial and the cervico-facial, branches from which form a plexus called the pes anserinus. This nerve **communicates** with the fifth, eighth, ninth, tenth cranial, great auricular from the cervical plexus and with the sympathetic plexus around the middle meningeal artery.

The principal **function** of this nerve is that of supplying motor impulses to the muscles of the face. It also transmits vaso-motor, secretory and gustatory impulses. Langley considers the seventh and ninth nerves together and states that the two together probably supply with autonomic fibers the whole of the mucous membrane of the nose and mouth. *"The fibers run in the several branches of the fifth nerve supplying the respective glands for stimulation of these branches causes secretion and after section of any one branch, stimulation of the seventh and ninth nerves has no longer an effect in the region to which the cut branch runs." It has been shown that the seventh nerve sends vaso-

*Schafer's Phys. Vol. II. p. 660.

motor impulses to the salivary glands, to the tongue, mucous membrane of the floor of the mouth and to the soft part of the palate. These impulses pass into the seventh nerve by way of the sympathetic plexus around the middle meningeal artery, which in turn receives its vaso-motor impulses by way of the superior cervical ganglion. This furnishes an explanation of why a cervical lesion will affect the parts supplied by the seventh nerve.

The **chorda tympani** nerve contains secretory and vaso-dilator fibers for the sublingual and submaxillary glands and also gustatory fibers for the margin and tip of the tongue. The gustatory fibers of this nerve probably originate in the glosso-pharyngeal and enter the facial through the pars intermedia. This nerve also contains fibers to the anterior lateral portion and tip of the tongue. It is possible that the facial also receives sensory impulses from the vagus. Muscle sense fibers are furnished to the facial by the trigeminus.

The principal **lesions** affecting the seventh cranial nerve are growths, fracture of the base of the brain, diseases of the ear, forceps pressure, and bony and muscular lesions of the neck. The most important **disease** of this nerve is **Bell's paralysis**, which consists of a paralysis of the lateral half of the face. This is usually a motor paralysis, although in some cases there may be pain. The eye on the affected side cannot be entirely closed, food gets in between the teeth and the cheek, patient cannot pucker the lips as in whistling or expectorating, and the voice is muffled. The wrinkles are smoothed out on the affected side, the mouth is drawn toward the sound side and the tongue cannot be protruded in the median line. The extent and degree of the paralysis is best brought out in attempted movements of the muscles of the face as in laughing or crying. In some cases there is tightening of the ear-drum which produces some disorder of the sense of hearing, while in other cases the chorda tympani branch of the facial is affected and is followed by some loss of taste. In the author's practice, most of the cases of Bell's paralysis resulted from cervical lesions such as contracture of muscles and displacement of vertebræ. Exposure to a draft, the catching of cold and injury from any cause will bring on an attack in some cases. Perhaps the best explanation of why a cervical lesion produces a paralysis is, that the vaso-motor supply to the **cells of origin** of the seventh nerve and the **nerve** itself and the **parts supplied** by the nerve, are impaired by the lesion, since the impulses pass up by way of the gang-

liated cord and on this account are subject to disorders. A contractured condition of the muscles of the neck in a similar way produces the effect.

As stated above the **vaso-motor nerves** from the superior cervical ganglion pass into the seventh nerve by way of the plexus around the middle meningeal artery. It has not been demonstrated as yet that motor impulses pass from the spinal cord up through this nerve, but judging from the short interval of time existing between the production of the neck lesion and the paralysis, one would infer that there is a direct motor connection which is broken by the lesion.

There are other disorders of the seventh nerve such as **blepharospasm.** It may be due to direct irritation of the facial nerve, or as Brubaker states, it may be caused by stimulation of the "sensory nerve of the eye principally in connection with scrofulous inflammation of the eye, or in consequence of excessive irritability of the retina." Often one unconsciously blinks when brought into a strong light. In pathological conditions in which there is photophobia, there often results a clonic spasm of the eye-lids. There may be other forms of spasm of the muscle supplied by this nerve in which there is fibrillary twitching, abnormal winking or histrionic spasms. As stated in connection with Bell's paralysis, these motor effects may result from a direct disturbance of the motor impulses, but since this is not definitely proven, it is better to explain the effects through vaso-motor and trophic disorders. In addition to these neck lesions it is recognized that intra-cranial disorders such as hemorrhages and tumors and injury of the periphery of the nerve, will produce disorders of the seventh, but back of these exciting causes there will be found in most instances, a neck lesion which is primary to the disorder, the exciting cause then acting the more readily. The writer has treated cases of facial paralysis due to mastoid abscess, inflammation of the middle ear and to polypi of the ear.

THE EIGHTH.

The **auditory nerve** is the nerve of the special sense of hearing. Gowers says that the deep origin is still involved in uncertainty. Its attachment to the medulla, (at the junction of this with the pons) is by two roots, one of which winds around the restiform body, (inferior cerebellar peduncle) while the other passes into the substance of the medulla. The nerve thus formed by the junction of these roots, is directed outward

to the internal auditory meatus in company with the facial nerve. The pars intermedia sends some filaments to the auditory nerve, but as to the kind of impulses carried by them, we are in doubt. It is supposedly trophic and vaso-motor.

The auditory nerve while in the meatus, divides into an upper or **vestibular** branch and a lower or **cochlear** nerve. The **vestibular** nerve, according to Landois, is essentially connected with the gray matter that is in relation with the cerebellum and probably subserves the purpose of maintaining the equilibrium. The **cochlear** nerve supplies the saccule, the posterior semicircular canal and is continued through the labyrinth as the cochlear nerve and is distributed to the organ of Corti. The auditory nerve then has two functions, namely, that of **hearing** and that of **maintaining the equilibrium of the body.** From this there may arise two sets of diseases one characterized by loss of, or interference with, the sense of hearing, and the other characterized by vertigo or disturbances of equilibrium.

The sense of hearing may be increased, decreased or lost. Stimulation of the nerve whether from a local condition or the result of a general nervous disorder as in hysteria, will produce a condition called **hyperacusis. Tinnitus aurium,** or ringing in the ears, is quite often due to a hypersensitive condition of the auditory nerve. In other cases, it is due to derangement of the mechanism that transmits the sound, which has been described before. The roaring in the ears from the taking of quinine is the result of congestion of the labyrinthine arteries, "which may increase to the degree of causing rupture of the vessel." It is also due to the poisonous effect of the drug. **Deafness** is more commonly due to a disturbance of the mechanism conveying the sounds than to a disorder of the apparatus that receives the impulses, that is, the auditory nerve. Deafness due to paralysis of the nerve, is diagnosed by inability of the patient to hear when the vibration is applied to the mastoid process, or other parts in which the medium is bone or other tissue. The other forms of disorder of the auditory nerve are characterized by vertigo, staggering gait, vomiting, roaring in the ears which symptoms make up the so-called Menieres' disease. The nerve in this disease may be affected reflexly, or it may be affected as the result of increased atmospheric pressure. Menieres' disease has been produced by forcible injections into the ears of rabbits and in addition to the vertigo, there was nystagmus and rotation of the head toward the affected side.

Some have attempted to prove that **seasickness** was due to a derangement of this nerve, but as yet no definite proof has been presented.

The lesions that involve the auditory nerve are those which produce direct pressure on it or those that interfere with its nutrition or circulation. Abscesses and diseases of the bone with which it is in relation, will produce a direct effect on it, while cervical lesions will affect its nutrition and vaso-motor supply.

The **vaso-motor supply** to the blood-vessels that supply the cells of origin of the nerve, seem to follow up the vertebral artery from the upper thoracic and lower cervical regions. Other vaso-motor impulses pass by way of the superior cervical ganglion and over the cavernous plexus either by way of the facial or glosso-pharyngeal nerves, the former by way of the pars intermedia, the latter by way of the tympanic plexus. Deafness is often caused by a subluxation of some of the upper cervical vertebræ. In most of those cases the tympanum and middle ear are involved. Occasionally a case is found in which the auditory nerve is involved as the result of a cervical lesion, but I believe it is an exceptional condition.

That the auditory nerve bears a close connection to vertigo, is indicated by the fact that it cannot be induced in deaf mutes, or in animals in which the labyrinths have been destroyed. The heart also has something to do with vertigo, and this tends to prove that the circulation of blood also has something to do with the production of the disorder, because in cases of weakness of the heart, or anemia of the brain, there is at least a tendency toward vertigo.

THE NINTH.

The **glosso-pharyngeal** nerve arises from nerve cells situated below the floor of the fourth ventricle. The filaments unite to form the nerve which emerges from the medulla between the olive and restiform bodies. The ninth is a mixed nerve but the afferent fibers predominate. The sensory descending root is from the fasiculus solitaris. Cunningham says: "It begins at the upper limit of the medulla, and can be traced downwards through its whole length. Its precise point of termination is not known but it is believed that it is carried for some distance downward into the upper part of the cord, viz., to the level of the fourth cervical nerve according to Kolliker." This tract is formed principally by the glosso-pharyngeal, while a few of the afferent fibers of the tenth enter it.

The nerve thus formed, passes out of the cranial cavity through the jugular foramen in company with the pneumogastric and spinal accessory nerves, but in a separate sheath of dura mater. It then passes downward between the hyoid bone and the lower jaw, is in relation with the carotid artery and ends in the tongue.

In the jugular foramen there are two enlargements or ganglia, the jugular and petrous. The petrous ganglion gives off the **tympanic** branch which with branches from the sympathetic filaments around the carotid artery, form the **tympanic plexus.** This plexus supplies the mucous membrane of the tympanum, the mastoid cells and the Eustachian tube. It in addition, communicates with the superior cervical ganglion, the auricular branch of the pneumogastric and sometimes with the ganglion on the root of the vagus. In the neck it gives off a branch that supplies the stylo-pharyngeus muscle and pharyngeal branches that innervate the muous membrane of the pharynx. There is a **tonsillitic** and a **lingual branch.**

Functionally, the ninth nerve is the **gustatory** nerve of the posterior third of the tongue and a part of the soft palate; the **motor** nerve for the stylo-pharyngeus muscle; the sensory nerve for a part of the tongue, epiglottis, tonsils, pharynx and the soft palate; **secretory** to the parotid gland and **vaso-motor** to the posterior part of the tongue, and the parotid gland. Langley states that sympathetic fibers pass to the posterior part of the tongue, the pharynx, and the larynx by way of the glosso-pharyngeal nerve, the pharyngeal and superior laryngeal branches of the vagus. Most of these impulses are derived from the spinal cord and reach the nerve by way of the cervical sympathetic and the branch of communication existing between the superior cervical ganglion and the glosso-pharyngeal.

Disorders of this nerve have not been accurately determined on account of the connection with the pneumogastric, thus making experimental study of the nerve quite difficult. Lesions of the neck affect the nerve by interfering with the passing of vaso-motor impulses to it and by disturbing the nutrition of the parts supplied by it. Diseases of the tonsils, parotid glands, tongue, and mucous membrane of the throat are predisposed to, or produced by, the lesion affecting the ninth nerve. Deglutition and respiration may also be affected since the nerve exerts an inhibitory influence on these acts. The writer saw one case in which there was marked pain in the posterior part of the tongue which resulted

from a lesion of the axis. The pain would come on in the form of a paroxysm accompanied by increased secretion of saliva. Certain kinds of food as well as sudden changes of temperature, would bring on the attacks.

THE TENTH.

The **vagus** nerve has its cell origin, in relation with that of the ninth and eleventh cranial nerves, in the floor of the fourth ventricle. Some of its fibers come from the solitary bundle of longitudinal fibers that extend down to the second cervical spinal segment. A motor nucleus called the nucleus ambiguus, which is situated further inward and is a continuation of the grey matter of the anterior horn, of the spinal cord gives off some fibers. The origin of the vagus and glosso-pharyngeal cannot be sharply separated and thus it is difficult to rightly interpret the various symptoms that arise from disorders of these nerves. The sensory fibers have their cells of origin in the ganglia situated outside of the medulla, viz., the petrosal and jugular ganglia.

The nerve thus formed passes out of the cranial cavity in company with the ninth and eleventh and in the same sheath with the spinal accessory. In the foramen, it has a ganglion on it called the **ganglion of the root,** and immediately after the accessory part of the eleventh joins it there is another ganglion called the **ganglion of the trunk.** It then descends in the neck in relation with the internal carotid artery and internal jugular vein, all of which are surrounded by a common sheath. The nerve can be reached at this part of its course, which is taken advantage of in certain palliative treatments for nausea and cardiac disorders. The two nerves differ somewhat in their thoracic relations but this is of no practical importance. It terminates in the various abdominal plexuses.

The first branch given off is the **meningeal,** which is distributed to the dura mater around the lateral sinus. It is **sensory** in function and in addition, may carry **vaso-motor** impulses. It may be affected directly in congestion of the brain, tumors and fractures of the base of the skull, and indirectly by cervical lesions that interfere with the nutrition of its cells and parts supplied by it. The principal effect of disturbance of it is headache in the back and side of the head. In cases in which there is pressure on it, there may be almost any sort of reflex disurbance such as nausea and throat disorders such as a chronic cough.

The **auricular branch** is distributed to the posterior and inferior part of the external auditory meatus, back of pinna, and according to Morris it also "supplies twigs to the osseous part of the external auditory meatus and to the lower part of the outer surface of the membrana tympani." It is called the **nerve of Arnold.** It communicates with the posterior branch of the facial and receives a branch from the petrosal ganglion of the glosso-pharyngeal nerve. It is supposed to supply the facial with sensory fibers at the point at which it crosses it, and with **muscle-sense fibers.** It is sensory to the parts of the ear which it supplies. Irritation of this nerve from foreign bodies in the external auditory canal, or accumulation and desiccation of the cerumen will produce in some cases, vomiting, coughing, cardiac disturbances and according to Landois, irritation of the auricular nerve will cause reflex contraction of the vessels of the ear. In some of the writer's cases, attacks of asthma could be induced by stimulation of this nerve. Dr. Still has suggested that a hardening of the wax in the auditory canal will affect the throat as in cases of croup. In his Philosophy of Osteopathy he says: "I began to think more about the dry wax that is always found in cases of croup, sore throat, tonsillitis, pneumonia, and all diseases of the lungs, nose, and head."

In speaking of a case of croup, he says: "On examination, I found the ear-wax dried up. So I put a few drops of glycerine and after a minute's time a few drops of warm water, in the child's head, and kept a wet rag corked into its ear at intervals for twelve hours and gave it osteopathic treatment. At the end of twelve hours all signs of croup had disappeared." As to the explanation of the functions of the ear wax and the effects of its desiccation he seems to think that it has to do with nutrition of certain parts of the body such as the nerves, since in paralytics, the wax on the affected side is found in great quantities that is, not absorbed for the nutrition of the nerves. Possibly the auricular branch of the vagus has something to do with the secretion of the cerumen and a hardening will cause reflex effects on parts supplied by the pneumogastric, viz., the throat and lungs. Neck lesions may affect this nerve by interfering with its nutrition and by affecting the secretion of ear-wax.

Fibers of unknown function **pass from the superior cervical ganglion** to the ganglia of the pneumogastric. It is supposed that they carry vaso-motor impulses from the ganglion to the vagus. A lesion of the

upper cervical vertebræ will affect this communicating filament and thus produce some disorder in some part supplied by the vagus.

Morris says: "Two twigs pass from the eleventh nerve to the ganglion of the root of the vagus, and at a lower level the accessory part of the eleventh nerve joins the ganglion of the trunk of the tenth. The majority of the fibers of the accessory part of the eleventh nerve merely pass across the surface of the ganglion of the trunk and are continued into the pharyngeal and superior laryngeal branches of the vagus, but a certain number blend with the trunk of the vagus and are continued into its recurrent laryngeal and cardiac branches." These filaments transmit motor fibers for the larynx, cardiac inhibitory, and possibly motor fibers for the pharynx, esophagus and the stomach. There are also anastomotic fibers between the vagus and the facial, the ninth, the twelfth and the loop between the upper two cervical nerves. The function of these connecting branches is unknown. These fibers are subject to injury in lesions of the atlas and axis and thus whatever function that they may possess will be impaired. The lesion affects them particularly by tightening the tissues in which they are located, while in some instances by direct pressure on them.

The **pharyngeal branches** of the pneumogastric nerve together with the pharyngeal of the glosso-pharyngeal and the superior cervical ganglion, form the **pharyngeal plexus.** The vagal branches are **motor** to the constrictor muscles of the pharynx, palato-glossus and palato-pharyngeal, and the elevator of the veil of the palate; **sensory** to the mucous membrane of the pharynx from the veil of the palate down. These sensory branches of the vagus take part in the reflex process of deglutition, and vomiting can be induced by irritation of them, as is demonstrated by the introduction of the finger into the throat. Disease of this nerve is characterized by difficulty in swallowing or pain in the throat. The food entering the pharynx from the mouth, lodges there instead of passing on down the esophagus. In some cases liquids may enter the larynx and cause spasms characterized by coughing or choking. Lesions of the neck affect the sympathetic filaments of the pharyngeal plexus and thereby induce symptoms that are attributed to a disease of this nerve. Spasm of the pharynx results from irritation of this nerve and is often associated with globus hystericus.

The **superior laryngeal nerve** is a branch of the lower part of the ganglion of the trunk and passes downward in relation with the carotid

arteries to its destination, the larynx. It divides into an internal and external branch, the **internal** supplying the mucous membrane of the epiglottis, the larynx, the mucous membrane of the cricoid cartilage anp communicates with the recurrent laryngeal. The **external** branch is distributed to the crico-thyroid muscle, a part of the mucous membrane of the larynx, and sends a branch to the heart which joins with one of those of the cervical sympathetic. It also furnishes a branch to the inferior constrictor, the pharyngeal plexus and receives a communicating branch from the superior cervical ganglion. The superior laryngeal nerve before dividing, receives a vaso-motor filament from the superior cervical ganglion. The external branch also receives vaso-motor impulses from the same source and is motor and sensory to the part supplied by it. The **internal branch is the sensory nerve** to the **epiglottis,** a part of the root of the **tongue** and to almost the entire **larynx.** Lesions of the neck will affect this nerve by interfering with the passing of vaso-motor impulses to it which are derived from the spinal cord by way of the superior cervical ganglion. These lesions will produce anemia or congestion of the larynx, hence sensory and motor disturbances. **Coughing** is one of the most common of these disturbances. It is a reflex process resulting from stimulation of some of these sensory branches of the pneumogastric. The impulses thus generated are carried to the cough center, which is supposed to be situated near the ala cinerea. This is a warning to the organism that there is something in the throat that should be expelled. The center may be stimulated by irritation of the nerve along its course, as well as by foreign bodies in the larynx which irritate the peripheral nerves. The center receiving the impulses, refers them to the throat it being mistaken as to their source and thus a cough is produced which consists essentially of contraction of the laryngeal muscles in order to expel the supposed foreign body. Thus irritation of any sensory branch of the pneumogastric may induce coughing, such as irritation of the external auditory canal, the nasal mucous membrane and the abdominal viscera. There are other afferent pathways to the cough center as is evidenced by the fact that stimulation of the uterus, ovary and mammary gland will often produce a cough. The important point to consider here is the fact that a lesion of the first rib and particularly the upper cervical vertebræ and the hyoid bone, will either directly irritate the superior laryngeal nerve by exerting pressure or traction on it, or indirectly affect it by interfering with the vaso-motor impulses to the

mucous membrane of the larynx. Landois quotes Hedon as finding in the superior laryngeal nerve vasodilator and secretory fibers for the mucous membrane of the larynx, and Kokin, in both laryngeal nerves secretory fibers for the mucous glands of the larynx and trachea.

The **inferior laryngeal** branches of the pneumogastric differ slightly in their course and distribution on the two sides. It is in relation with the trachea, the arch of the aorta and the esophagus and hence is likely to be affected in diseases of these structures. Functionally, it is the **motor nerve of the larynx,** supplying all the muscles with the exception of the crico-thyroid. These motor fibers are supposed to be derived from the spinal accessory nerve. It also supplies the **esophagus,** the **trachea, inferior constrictor of the pharynx** and gives off a **cardiac** branch, and twigs of communication with the inferior cervical ganglion of the sympathetic. The lesions that affect this nerve are located in the cervical and upper thoracic area, especially the lesions of the upper two ribs. These subluxations, especially affect the nerve through the vaso-motor supply of the larynx. Since the larynx is the organ of voice and is supplied by the laryngeal nerves with motor, sensory, vaso-motor and possibly secretory impulses, lesions, affecting the cells of origin, exit or course of these nerves, produce disorders of the voice, ranging from hoarseness to aphonia.

The **cardiac branches** of the pneumogastric are supposed to carry inhibitory impulses to the heart which are thought to be derived principally from the spinal accessory nerve. Some writers claim that stimulation of this nerve will produce acceleration of the movements of the heart, especially if the irritation is a feeble one. It is supposed also to carry sensory and vaso-motor impulses. Landois cites the following experiment in support of the existence of vaso-motor fibers in the cardiac branches: "Persistent irritation of the peripheral stump of the vagus causes extravasation of blood into the endocardium (long continued poisoning with digitalin or strychnin had a similar affect) in consequence of spasmodic contraction of the endocardial vessels with secondary paralytic relaxation and rupture." The accelerator function of the vagus in reference to the heart, is supposed to be derived from the sympathetic fibers. Clinically, these cardiac branches are of no great importance to us since it is the exception for lesions in the neck to affect the heart.

The **pulmonary branches** of the vagus help to form the anterior and posterior plexuses and supply sensory and motor fibers to the trachea

bronchi and lungs. They also are supposed to supply vaso-motor nerves to the pulmonary vessels. Lesions of the upper ribs, from a clinic point of view, seem to affect these nerves more frequently than do cervical lesions. Possibly this is through direct connecting filaments or through sympathetic fibers that help to form the pulmonary plexus. The writer has made several dissections in which there was found branches running from the upper thoracic sympathetic ganglia directly across into the pneumogastric. The principal diseases associated with this nerve are asthma and chronic cough. **Asthma** is probably the result of vaso-motor disturbances of the mucous membrane of the bronchi from lesions of the upper thoracic vertebræ and ribs. Coughing is most frequently due to lesions higher up, especially of the first and second ribs and the cervical vertebræ. I am inclined to believe that most of these disorders result from vaso-motor disturbances of the blood-vessels supplying the parts to which these nerves are distributed, thus making the effect the result of a peripheral irritation instead of stimulation along their course. The inhalation of certain gases, the entering of food into the larynx and trachea, and congestion of the bronchi produce cough.

The **esophageal branches** of the vagus convey motor and sensory impulses to the esophagus. They first enter the plexus gulæ which is formed by branches from the splanchnic nerves before they reach the solar plexus, and these branches of the vagus. **Dysphagia** is the principal effect of involvement of these nerves. The writer has seen a few cases of pain in the lower part of the esophagus during deglutition which seemed to be the result of swallowing too large a bolus of food, some foreign body or due to hasty swallowing.

The **abdominal branches** of the vagus which supply the stomach, spleen, liver, kidney and the greater part of the intestinal tract carry motor, vaso-motor, secretory and sensory impulses. The principal function is that of conveying motor impulses to the gastro-intestinal tract. Stimulation of the nerve excites contraction of the stomach, especially the right half and secretion from the gastric glands. Clinically, it seems that the function of the abdominal branches of the pneumogastric is controlled by the sympathetic nerves of the part, since diseases of these parts seldom result from neck disorders but from lesions in the middle thoracic area. Occasionally neck lesions are found which are responsible for the disorder of the abdominal viscus, but this is the exception rather than the rule, hence we conclude that the function of the

abdominal branches of the pneumogastric is controlled by the sympathetic nerves derived from the middle thoracic ganglia and the spinal cord, since the lesions are found here.

The vagus nerve contains **depressor fibers** which on stimulation, reflexly inhibit the heart's action, dilate the peripheral arteries and produce a fall of blood pressure. Some writers seem to think that all sensory nerves contain both pressor and depressor fibers. Landois says, "Irritation of depressor nerves, particularly if intense and long continued, causes dilitation of the vessels in the areas innervated by them. Pressor fibers are present in the superior and inferior laryngeal nerves, the fifth cranial and cervical sympathetic. Irritation of this nerve will produce a pressor effect." Congestion of the lungs produces an acceleration of the heart beat through the action of the depressor nerve. Quain says in his summary of the pneumogastric nerves: "They convey fibers to the voluntary muscles of the soft palate, (with the exception of the tensor palati) pharynx and larynx, these being in part, at least, derived originally from the spinal accessory,to the unstriped muscle of the alimentary canal—esophagus, stomach and intestine (with the exception of the rectum) and of the air passages—trachea, bronchi and their divisions in the lungs. Sensory fibers are furnished to the pharynx, esophagus and stomach, to the larynx, trachea and bronchial ramifications as well as to the dura mater, external ear and the pericardium. The vagi also supply nerves to the heart, both efferent (inhibitory—also received from the spinal accessory) and afferent (depressor) and possibly inhibitory dilator fibers to the vessels of the intestine. Lastly, pneumogastric fibers pass either directly or through the solar plexus and its offsets to the liver, pancreas, spleen, kidneys and suprarenal bodies. Each pneumogastric nerve is connected with the following cranial nerves: the spinal accessory, glosso-pharyngeal, facial and hypo-glossal; also some spinal nerves; and with the sympathetic in the neck, thorax and abdomen."

Physiologically, the pneumogastric is connected with the **centers** in the medulla and controls at least in part, some of the most important functions in the body. It is connected with the vaso-motor center, which is situated in the medulla, by way of the pressor and depressor nerves. Respiration is partly under the control of the vagus through the pulmonary and laryngeal nerves, which connect with the respiratory center in the medulla. The vomiting center is stimulated by af-

ferent impulses passing over the vagus. The cardiac centers are in connection with this nerve and thus the pulse rate is in a measure governed by the impulses passing over the vagus. The secretion of the pancreas is to a great extent under the control of the pneumogastric while Bernard says that irritation of the pulmonary branches causes a reflex increase in the formation of sugar in the liver, perhaps through the intermediation of the hepatic branches.

Experimentally, many and varied reflexes can be obtained by stimulation of the vagus nerve. It is the seat of much referred pain, especially in the head and neck. Schafer says: "Referred pain by way of the vagus occurs in part of the region of the fifth cranial nerve and of the upper cervical nerves; hence, we must suppose that the roots of the vagus have intimate connections with the roots of the fifth and of the upper cervical nerves. Certain deep structures of the head such as the iris, tooth pulp, tongue, cause referred pain in the skin region of the fifth nerve, and, taken together, in the whole region of the fifth." Coughing, asthmatic attacks, spasms of the larynx, of the glottis, angina pectoris, and other cardiac disturbances, vomiting and vaso-motor disorders are quite frequently produced reflexly on account of the wide distribution, many connections and intimate relation of the vagus with the centers in the medulla.

Clinically, the vagus is affected by lesions of the cervical vertebræ, hyoid bone, upper thoracic vertebræ, upper ribs, by muscular contractures in these areas, and peripherally by foreign bodies in, or disease of, the mucous membrane lining the various cavities supplied by the vagus.

THE SPINAL ACCESSORY.

The **eleventh cranial**, arises from two sources. The medullary or **bulbar portion** arises from the nucleus ambiguus in connection with fibers that form the pneumogastric. The fibers thus formed pass forward and emerge from the medulla with the roots of the vagus. The **accessory portion** of the nerve arises from the cells in the anterior horns of the gray matter of the spinal cord as low as the seventh cervical segment. The fibers thus formed pass out of the spinal cord between the anterior and posterior roots of the cervical nerves, and form into a trunk that ascends through the foramen magnum andunites with the medullary portion to form the common trunk. The nerve then emerges from the cranial cavity through the jugular foramen in the same sheath with the

pneumogastric. Cunningham says: "In the jugular foramen the accessory portion of the nerve (after furnishing a small branch to the ganglion of the root of the pneumogastric nerve) applies itself to the ganglion of the trunk and in part joins the ganglion, in part, the nerve beyond the ganglion. By means of these connections the pneumogastric receives viscero-motor and cardio-inhibitory fibres." This branch soon enters the pneumogastric and eventually supplies the pharyngeal and laryngeal muscles, the latter through the recurrent laryngeal nerve.

The spinal or accessory portion, passes into the neck in relation with the carotid artery and internal jugular vein, communicates with the second, third and fourth cervical nerves and supplies the sterno-mastoid and trapezius muscle.

Spinal lesions will affect the functions of this nerve, especially the accessory portion by interfering with its nutrition. This is the result of tightening of tissues and pressure on the blood-vessels that supply and drain the cervical spinal cord.

The principal **effect** of a lesion involving this nerve is **torticollis.** This will follow both an inhibitor and a stimulating lesion, the first producing a paralysis of the muscle, while in the latter case there will be a spastic or clonic effect with structural changes of the muscle. In addition to these effects there may be, as a result of the effect of the lesion on the spinal accessory nerve, impairment of deglutition on account of weakening or paralysis of the constrictor muscles of the larynx, disturbance of the heart, disturbance of the vocal cords and some form of respiratory disorder, especially shortness of breath, on account of effect on the muscles.

THE HYPOGLOSSUS.

The **hypoglossal nerve** has its deep origin in the floor of the fourth ventricle from cells that are continuous with those of the anterior horns of the spinal cord. The fibers are arranged in two bundles that unite to form the nerve before it makes its exit from the skull through the anterior condyloid foramen. It passes downward and forward across the carotid artery, is in relation with the great cornu of the hyoid bone and enters the tongue by passing between the mylo-hyoid and hyo-glossus muscles. At its origin it is a purely motor nerve but through its connections, receives sensory and other fibers.

The nerve is **motor** to the intrinsic muscles of the tongue, the hyoglossus, genio-hyoid, genio-hyo-glossus, thyro-hyoid and possibly some of the infra-hyoid muscles although they in all probability receive most of their motor impulses from the cervical nerves.

It receives its **sensory** fibers from the vagus and the upper cervical nerves. (Dana). **Muscle sense** fibers pass into the nerve from the pneumogastric.

Vaso-motor impulses pass into the nerve **from the superior cervical ganglion,** which in turn are derived from the spinal cord. This is proven experimentally, since division of the hypoglossal is followed by redness of the same side of the tongue. Lesions of the upper cervical vertebræ affect this nerve principally through its connections, especially through the superior cervical ganglion.

The most common of the disorders of this nerve are manifest by motor effects on the tongue. Disorders of articulation, deglutition and mastication are not unusual. **Stammering** is sometimes the result of disease of the lingual muscles but in most cases is the result of a habit. The same is true of stuttering. The writer has treated cases of spasms of the tongue due to lesions of the axis which undoubtedly affected the hypoglossal nerve. Bulbar disease and neuritis, will produce hemiatrophy of the tongue. In such cases the cervical lesions that are usually present, interfere with the nutrition of the medulla and the nerve itself.

All the cranial nerves are more or less affected by **lesions of the cervical and upper thoracic vertebræ.** The best explanation is that all of them receive directly or indirectly, vaso-motor impulses from the spinal cord and the circulation and nutrition of the nerves and their nerve cells depend on the condition of the vaso-motor nerves that pass into the brain from the spinal cord principally by way of the cervical sympathetic. Lesions in the above mentioned regions interfere with, in some way, the formation and passing of vaso-motor impulses to the parts above, hence the disorders of the cranial nerves. These lesions affect the vaso-motor nerves by lessening the size of the intervertebral foramina through which pass the nerve fibers and blood-vessels that nourish the cells in that part of the spinal cord from which these fibers arise. Clinically, there is no doubt about the statement that cervical and other bony lesions affect the cranial nerves, since it has been so often absolutely demonstrated.

THE BRAIN.

The **brain** or encephalon is that portion of the central nervous system that occupies the cranial cavity. No detailed description will be attempted here but only those parts that are frequently diseased will be discussed. **Most disorders of the brain arise from extra-cranial causes** while some come from causes acting from within. It is our purpose to explain, if possible, the various symptoms that arise from affections of the brain from an anatomical viewpoint, that is, showing that its diseases, like disorders of other parts of the body, result from anatomical displacements.

The **cerebrum** constitutes over eighty per cent of the weight of the entire brain. It is divided into two parts. by the longitudinal fissure, which parts are connected by the corpus callosum. Its surface presents an undulated appearance, the indentations or depressions are known as **fissures** and the prominences, as **convolutions.** The principal fissures are, the fissure of **Sylvius,** of **Rolando, parieto-occipital, calloso-marginal** and the **calcarine** fissure. These fissures are of interest to us in that they divide the cortex into lobes and convolutions and serve as landmarks for the locating of the various cortical centers. The principal **lobes** of the brain are the frontal, parietal, occipital, the temporo-sphenoidal and the island of Reil.

The **frontal lobe** includes that portion of the cerebrum that lies in front of and above the fissure of Sylvius and in front of the fissure of Rolando and on the inner side, that part above the calloso-marginal fissure. The function of this lobe has been fairly well ascertained from experiments on monkeys and by clinical observations in cases of injury to the part. Gowers includes in his description of the frontal lobe the anterior part of the parietal. He states that destruction of it produces hemiplegia on the opposite side, with secondary degeneration of the pyramidal tract, and rigidity of the limbs; a partial lesion affects face, arm, or leg according to its position. "Partial lesions are very common first, on account of the wide extent of the central region; and secondly, because the region is supplied by different arterial branches and softening from their occlusion is frequent." The leg and arm are more frequently affected than the face and monoplegia is often due to disease of the cortex.

Irritating diseases of this area will produce convulsion of the face,

arm or leg. In some cases there are some sensory disturbances as a result of disease of the central part of the cortex of this lobe. It is the exception for any motor effects to follow a disease of the anterior portion or what is called the prefrontal lobe. The principal effect is on mentality and the movements of the head and eyes. "A large number of cases are on record of disease and injury of various kinds in this part, in which psychical disturbance was the only symptom."

The **parietal lobe** includes that portion of the outer and inner portion of the surface of the hemisphere which is bounded anteriorly by the fissure of Rolando, below by the fissure of Sylvius and posteriorly by the parieto-occipital fissure.

Disease of the anterior and superior part of this lobe produces **disorders** of the **movements** of the limbs. **Ptosis** results from disease of the lower part, while if the posterior part of the lobe is affected, some form of eye disorder may result such as hemianopia, crossed amblyopia or there is an interference with the "visual perception of words." The center for general sensation is probably in part situated in the parietal lobe.

The **occipital** lobe embraces the posterior part of the cerebrum. The important point associated with it is that in it are located the centers for vision. If only one side is involved there will be hemianopia. Dana says: "The special senses have two centers—the primary and the secondary. The primary are situated in the ganglia at the base of the brain; the secondary, are in the cerebral cortex." The occipital lobe is the secondary center for visual impulses from the corresponding half of the retina of each eye.

The **temporo-sphenoidal** lobe lies below and behind the fissure of Sylvius. The primary center for hearing is located in this lobe. Each center controls the sense of hearing on the opposite side.

These various lobes are affected by **pressure,** as in fracture of the cranial vault, **congestion, extravasation of blood** as in hemorrhage and by the lodging of **emboli.** Nutrition may be affected by other means which will be discussed later.

The **corpus callosum** is a great transverse commissure, considerably arched from before backward, that connects the hemispheres. It is composed entirely of white fibers that connect the cortex of one side with the gray matter of the opposite hemisphere. Since its function seems to be that of furnishing a connecting tract between the hemi-

spheres, the destruction of it would not materially interfere with the independent action of either side. Gowers says: "We do not yet know of any symptoms that are the result of the damage to the callosal fibers."

The **internal capsule** consists of a band of white matter that embraces the inner side of the **lenticular nucleus,** hence the name capsule, and separates this nucleus from the caudate. Brubaker says: "It consists of nerve fibers which associate histologically and physiologically all portions of the cerebral cortex with the optic thalmus, pons, medulla, spinal cord and cerebellum." The **corona radiata** converge from the cortex and are condensed to form a part of the capsule. **Motor impulses** pass by way of the capsule to the muscles of the opposite side of the body. Afferent impulses from "skin, mucous membrane, muscles, and special sense organs," pass through the internal capsule. The **motor tract** lies in the posterior third of the anterior part and the anterior two-thirds of the posterior segment. The **sensory tract** occupies the posterior third of the posterior segment, the optic and auditory tracts being located in the extreme part. The anterior part is supposed to contain psychic paths to the frontal lobes. On account of the number and character of impulses transmitted by the capsule and the numbers of cases in which it is diseased, it is one of the most important parts of the central nervous system viewed from a pathological standpoint. Lesions of the anterior part ordinarily produce few if any disorders, of the middle portion motor effects, while if the posterior part is destroyed there will be sensory paralysis of the parts supplied by the fibers destroyed by the lesion. On account of the proximity of the fibers composing the capsule, a small lesion will produce a wide effect as is demonstrated by hemiplegia.

The **corpus striatum** consists of a large mass of gray matter, hence called a ganglion, that lies at the base of the hemisphere beneath the lateral ventricle. It is divided into two parts the caudate, and the lenticular nucleus. *Dana says: "This ganglion is in close relation with the cerebellum and with nuclei in the pons. It is also in connection with fibers that come up from the muscle-sense tract in the spinal cord. Its functions are then probably connected with securing co-ordinate and purposeful movements. Destruction, however, of this ganglion in the human brain produces no definite symptoms, and local lesions of it cannot be diagnosticated. It is therefore called a "latent region." It is believed that axons of cells in the frontal lobe pass to the corpus striatum.

*Text-Book of Nervous Diseases, p. 377, 1901.

Schafer in speaking of the function of this ganglion says that it is generally believed to act as a center for the higher reflex movements and to be in close association with the Rolandic area, but the experimental grounds for this belief are still lacking.

The **optic thalami** consist of two masses of gray matter located in the lateral walls of the third ventricle. It is connected with the various lobes of the brain, that is the various sense centers, by means of its projection fibers. The fibers that go to the occipital lobe are connected with the function of seeing while those that connect with the temporal lobe, have to do with the function of hearing. In injuries of the optic thalami, no definite symptoms occur if the lesion is confined to the anterior part and the internal capsule is not involved. If the posterior part is involved, the eyes are generally affected, a crossed blindness or hemianopia being the result. It also has to do with co-ordination, facial expression and possibly with the special sense of touch, taste, smell, hearing and muscle-sense. The centers for complex reflexes and the reflex center for the secretion of tears are supposed to be located in the optic thalami. The **principal effect** of a lesion of the optic thalami is some sort of **eye disorder,** blindness being the most common.

The **corpora quadrigemina** consist of masses of gray matter which are in relation with the posterior part of the corpus callosum, the third ventricle and the aqueduct of Sylvius. The function of these bodies is not well understood but they are supposed to have to do with vision, ocular movements, equilibrium and hearing. Isolated disease of them is rare but they are affected by congestion and hemorrhage. They are also associated with station and locomotion and Ferrier states that in these bodies "sensory impressions, retinal and others, are co-ordinated with adaptive motor reactions such as are involved in equilibrium and locomotion." The various cervical lesions will affect the nutrition and circulation of these bodies since in all probability, the vaso-motor nerves to the blood-vessels of these parts come from the superior cervical ganglion, or admitting that the blood-vessels of the brain have no vaso-motor nerves, the blood volume and circulation are dependent on the cervical ganglia, consequently disorders of the neck will affect the circulation of the brain as has ofttimes been demonstrated clinically.

The **crura cerebri** are situated between the pons and the cerebrum. They are composed of white matter arranged in layers, the ventral and dorsal portions. These parts are separated by a layer of gray matter

called the **substantia nigra.** The ventral fibers are to a great extent, derived from the pyramidal tracts and are continuous with those of the pons and the medulla. These fibers are motor in function. The dorsal portion of these fibers, often called the **tegmentum,** are continuous with the fibers that pass upward from the medulla, pons and the superior peduncles of the cerebellum. These fibers transmit sensory or afferent impulses. Lesions of the crura cerebri are, therefore, characterized by hemiplegia of the face and limbs of the opposite side, which is often complicated by sensory paralysis of the same parts, if the lesion involves the dorsal portion of the crura. On account of the proximity of the third nerve, it is also involved in some cases of disease of the crura which is followed by paralysis of the eyelid on the same side. The nuclei of other cranial nerves may be involved if the lesion is a deep one.

The **pons Varolii** is situated between the medulla below, the crura cerebri above and the cerebellum posteriorly. It is composed of white and gray matter and serves as a medium through which impulses pass both from below upward and from above downward. The posterior surface of the pons forms the floor of the fourth ventricle and consists of gray matter that gives rise to the fifth, sixth, seventh and eighth cranial nerves. The fifth, sixth and seventh cranial nerves traverse the pons in their course from their nuclear to their apparent origin. On account of this, a lesion occurring in the pons will affect one side of the body, and the opposite side of the face, if it falls on the facial roots before they decussate and this is the rule. Such a paralysis is called a crossed or alternating paralysis. The **tracts** that are always affected are the pyramidal, and paralysis of the opposite side of the body is the result. If the upper or posterior parts of the pons are affected, there will be a sensory as well as a motor paralysis, since the sensory tract lies in this part. If this part is involved, the motor nucleus of the sixth nerve is affected and there will be a conjugate deviation of the eyes toward the side of the lesion, that is away from the paralyzed side.

The speech-paths which lie in the posterior part of the pyramidal tract, may be affected by a lesion of this area and speech disturbances follow. In some, the oculo-motor and fifth nerves are involved by the lesion. Church says "A lesion which cuts the sensory root-fibers of the fifth, induces anesthesia in the face on the same side and crossed paralysis in the limbs through injury to the pyramidal tract. Rigidity, spasm, and choreic movements in the limbs are sometimes encountered, and

convulsions in acute diseases are common. If the middle cerebellar peduncle is affected, vertigo, vomiting, and tinnitus are usually present, and deafness on the same side may ensue." Lesions of this part are not unusual and can in many cases be traced to subluxations in the cervical region that disturb the trophic and vaso-motor impulses to the blood-vessels of the part.

THE MEDULLA OBLONGATA.

The **medulla oblongata** which is a continuation upward of the spinal cord, lies on the basi-occipital bone in front of the cerebellum and below the pons into which it merges. It is composed of gray and white matter. The **gray matter** is continuous with that of the spinal cord but the arrangement of the cells is different. It forms the various centers located in the medulla which have so much to do with the vital, and other functions of the body. The **white matter** is arranged in columns that are really continuous with those of the spinal cord. The anterior part or pyramids of the medulla "serve to conduct volitional efferent nerve impulses from higher portions of the brain to the spinal cord." The dorsal part of the medulla, transmits sensory or afferent impulses from the spinal cord to the brain above. Transverse section of the motor tract will be followed by motor paralysis of all muscles receiving their supply through them. Section of the afferent tract on one side is followed by complete loss of sensation on the opposite side of the body.

There are located in the medulla many **centers** that reflexly control important functions of the body. The spinal cord centers are controlled to a great extent by the predominating centers in the medulla. These centers are affected by many things but the most important is the blood, its quality and amount. Any pathological change in the character and amount of the blood circulating through it will affect the function of these centers. In all reflex processes there must be a stimulation an afferent nerve, a center for receiving the impulse and an efferent tract.

The center for **sneezing** is stimulated by impulses that reach it by way of the fifth nerve, its nasal branch, and possibly by way of the olfactory. The efferent impulses thus stimulated, pass to the expiratory muscles, and a spasmodic contraction of them completes the act. This is nature's method of ridding the body of a foreign object or what is supposed to be injurious to the respiratory tract. **I believe it to be nature's method of "throwing off" a cold.** If a person who has contracted a cold

can sneeze freely, I believe, from cases seen, that it can be aborted.

Congestion of the nasal mucous membrane is the most common of the irritations that produce activity of the center. In hay fever, the nasal mucous membrane is intensely congested even to the point of capillary hemorrhage. This produces attacks of sneezing that are almost uncontrollable. **Pressure on the upper lip** or lower part of the **nasal septum** will ordinarily stop sneezing. Lesions of the neck both muscular and bony, produce congestion of the nasal mucous membrane and in acute cases, will produce sneezing.

The **cough center** is reached principally through the sensory branches of the pneumogastric. The efferent impulses pass over the expiratory nerves. The usual point of irritation is in the throat from congestion of the mucous membrane. Irritation of other branches of the vagus will in some cases, produce cough. Disorders of the stomach, uterus, rectum, bronchi, intestines and the external auditory canal often reflexly produce coughing. Lesions of the cervical vertebræ, upper ribs, and hyoid bone are the important ones to be considered in the usual cases. Like other reflex processes, an irritation of the afferent nerves, center or efferent nerve will produce a cough. In upper rib lesions especially, the cough center is mistaken as to the source of the impulses, they coming from the trunk of the nerve instead of the periphery. This gives rise to a chronic, hacking cough. Cervical lesions often produce a cough by producing a peripheral congestion in the mucous membrane of the respiratory tract.

The secretion of **saliva** is a reflex process with the center in the medulla. Landois says: "Irritation of the medulla oblongata when the chorda tympani and the glosso-pharyngeal nerves are preserved, causes active secretion of saliva; a lesser amount of secretion when these nerves are divided; and, finally, none at all when the cervical sympathetic also is destroyed." Lesions of the cervical vertebræ affect the secretion of saliva by disturbing the above nerves, especially the cervical sympathetic, and by disturbing the circulation to the medulla.

The **respiratory** center, which consists of two areas, the inspiratory and the expiratory, is located in the medulla. Its activity in the normal case is governed by the condition of the blood. If the blood is properly oxygenated respiration will be slow, but if imperfectly aerated, as during violent exercise, the center will be excited by the venosity of the blood. The center may be affected by stimulation of the afferent nerves as in

pain, by a peripheral disorder as in asthma, but most commonly by changes in the blood circulating through the medulla. A lesion of an upper cervical vertebra will affect the circulation through the center and thus produce respiratory disturbances. This center co-ordinates the muscles of respiration, which is a decidedly complex process. The vagus is the most important of the nerves that connect with the respiratory process, which is determined by the effects of stimulation and section of it. If one of these nerves is cut, the respiration becomes slowed while if both are severed, the breathing becomes markedly abnormal and the injury will result fatally after a short while.

A **cardiac center** is located in the medulla which exerts an accelerator influence on the heart's action by way of the spinal cord, and the upper thoracic sympathetic nerves, and an inhibitor action, through the spinal accessory part of the pneumogastric. This center is closely related in function with the respiratory, so that venous conditions of the blood that stimulate the respiratory, will also increase the heart's action through the accelerators.

Disease of the medulla, as in bulbar paralysis, produces enormous retardation of the pulse-beat. Functional disorders sometimes result from lesions of the upper cervical vertebræ that impair the nutrition and circulation of the medulla, thereby affecting the activity of the cells that give rise to the above named nerves. Lesions of the upper thoracic vertebræ, will interrupt the passing of impulses between the cardiac center in the medulla and the centers in the upper segments of the thoracic spinal cord and the heart.

The predominating vaso-motor **center for the blood-vessels** of the body is located in the medulla. It is in constant action maintaining the tone of the arteries and perhaps that of the veins. It is not only affected reflexly by blood changes, but by the condition and amount of blood circulating through the medulla. Since lesions of the upper cervical vertebræ affect the circulation through the bulb, it follows that the vaso-motor center will be affected by these lesions. These lesions also interfere with the connection that exists between the predominating center in the medulla and the secondary centers situated in the spinal cord. On this account, the passing of impulses from the spinal cord to the medulla is interrupted, and the center is not kept well informed as to the condition of the subsidiary centers, or else the passing of impulses from the higher center to the subsidiary center is impaired and thus the subsidiary cen-

ters are left to act independently of the bulbar. Blood pressure can be lessened by inhibition in the suboccipital fossa, this being determined from clinical observations. The probable explanation is that the activity of the predominating center in the medulla is lessened or rather the excessive activity of it is lessened by the treatment, since it temporarily relieves or removes the cause of the irritation of it.

Deglutition is a reflex process and has its center on the floor of the fourth ventricle. **Afferent** impulses reach it over the sensory branches of the fifth and pneumogastric nerves, that supply the palate and pharynx. The **efferent** pathway is through the motor branches of the pharyngeal plexus. **Dysphagia** may follow neck lesions that interfere with this reflex process by disturbing the periphery as in congestion and inflammation of the throat, the afferent nerve, the center or the efferent nerve. These parts are in relation with the cervical vertebræ and would be directly or indirectly affected, by a cervical lesion.

The **vomiting center** is situated in the medulla, the afferent impulses reaching it over the branches of the pneumogastric. The efferent tract is by way of the expiratory muscles, that is the nerves that control expiration. The intercostal nerves are the important ones concerned in vomiting since it can with difficulty, if at all, take place if the abdominal muscles are paralyzed. Contraction of only the abdominal muscles is sufficient to produce vomiting, which is determined by experiments in which the other muscles are paralyzed. Clinically, lesions that affect either the afferent or efferent nerves will tend to bring on an attack, but the most common form is due to peripheral irritation resulting from the presence of a foreign body in or abnormal condition of, the alimentary tract. Since the efferent impulses pass almost entirely through the thoracic spinal cord and out over the upper thoracic nerves, pressure, that is inhibition, applied to these points will often intercept the motor impulses and thus relieve the vomiting.

The center for **hiccough** is a part of the respiratory apparatus and is affected by disturbances of the nerves that control respiration. The stimulation is usually at the periphery, that is at the diaphragm or along the course of the phrenic nerve. The lesions are found in the lower ribs the clavicle, first rib and the cervical vertebræ. It is the exception for the center to be directly affected but it is possible for a lesion to so affect the blood supply to the medulla, that this center will be affected. The effect of such a lesion is most marked on other parts of the respiratory apparatus.

Mastication and **sucking** are reflex processes that have their centers in the medulla. The afferent nerves are the fifth and glosso-pharyngeal. The motor impulses pass out over the facial, hypoglossal and the trigeminus.

Closure of the **eyelids** is a reflex process, the center being in the medulla. The fifth cranial nerve transmits the afferent, while the facial carries the motor impulses. Intense light or a foreign body in the eye, are the important sources of irritation. In Bell's paralysis, this reflex process is impaired so that particles of dust and other irritants enter the eye and there set up an inflammation. The secretion of tears is also a reflex process and serves to keep the eye bathed, thus washing out particles of dust that collect in the eye. These processes are impaired by neck lesions that affect the center the fifth or the seventh nerve.

Dilatation of the **pupil** is also a reflex process and in normal cases is governed by the amount of light that enters the eye, shutting off the light stimulating the center. The most common lesion that affects this center or process, is found in the upper thoracic region. The writer has seen cases in which the pupil could be dilated by pressure at the third thoracic spine. In another case the pupil could be voluntarily dilated. The condition of the blood circulating through the medulla and other tracts in relation that have to do with the eye, is the most important factor in cases in which there is some disorder of the pupil. In cerebral hemorrhage and certain forms of poisoning, the pupil is affected. In some forms of spinal cord disease, the pupil is changed as in tabes dorsalis, i. e., narrowed by means of paralysis of the cervical sympathetic.

The **sweat center** situated in the medulla, is an **automatic one** and is the dominating center for the secretion of sweat for the entire surface of the body. The condition of the blood, activity of the heart and the cervical lesions are factors that determine the activity of this center. It can possibly be stimulated to increased activity by manipulation in the upper cervical region, which treatment is often resorted to in fever cases. Cervical lesions will produce a unilateral stimulation of this center, it being bilateral, and thus produce a **hemidrosis.**

At the junction of the medulla and the pons, there is a spot which, when stimulated, produces a spasm, it being called the **spasm center.** This center is affected principally through venosity of the blood. (Landois). Anemia if sudden, will also bring on a convulsion. Clinically, there is found in most of the cases of spasms, a lesion of an upper

cervical vertebral articulation that disturbs the circulation through this part of the medulla. In such lesions the blood in the center becomes venous in character and the center is thus stimulated into activity, the degree of the spasm depending on the amount of toxic matter in the blood. Spasms can often be checked by treatment applied to the sub-occipital fossa especially if applied in the beginning of the attack. This treatment consists of freeing up the drainage of the medulla by relaxing the contractured muscles and by adjusting the vertebræ, an approximation being the common form of derangement. In epileptic attacks, strong pressure applied to the sub-occipital region, will in most cases stop the attack. It has been ascertained that "irritation of sensory nerves may cause both sudden contraction as well as dilatation of the cerebral vessels." If this condition takes place in the medulla, anemia or transitory congestion will result, either of which will produce convulsions in that such conditions irritate the medulla. This is particularly true of epileptiform convulsions.

The **functions** of the medulla are affected by local lesions, that is in the upper cervical region, that interfere with the circulation to, and nutrition of, the medulla and by other lesions that impair the quality of the blood. Even those lesions that impair the quality of the blood need not necessarily affect the medulla, unless the local lesions are present which further increase the venosity of the blood by causing a congestion of the vessels of the medulla.

CEREBELLUM

The **cerebellum** is situated below the posterior part of the cerebrum and rests in the inferior fossa of the occipital bone. It is separated from the cerebrum, by a partition of dura mater called the **tentorium cerebelli.** The **cortex** is composed of grey matter which surrounds the white matter within. It is partially divided into hemispheres, each one of which is connected by peduncles, the superior, middle and inferior, which connect respectively with the cerebrum, pons, medulla and spinal cord. The **function** of the cerebellum is that of **co-ordinating** and harmonizing the action of the muscles that control the equilibrium of the body. In experiments performed in which the cerebellum is totally removed, there is no loss of sensation or weakness of the muscles, but **inco-ordination** of the muscles is the principal effect. The maintaining of equilibrium is through the connections with the other parts of the brain. Landois

says: "Through the lateral cerebellar tracts stimuli are conveyed to the cerebellum and these serve as guides to the position of the trunk. Connections of the vestibular nerve with the cerebellum have a similar effect with respect to equilibrium. The cerebellum may influence the motor nerves of the spinal cord through fibers that pass downward through the restiform body into the lateral tracts of the spinal cord. The cerebellum itself is insensitive to injuries." It also has to do with the strength of voluntary movements, tone of muscles and the rhythm of the motor impulses. Diseases of the cerebellum are characterized by disorders of co-ordination, such as a staggering or drunken gait, vertigo, ataxia and malnutrition of muscles. The disease may extend upward from the spinal cord or may be the direct result of lesions that affect the nutrition of it.

The brain is divided into several **areas** that have to do with particular functions, namely: the **motor, sensory** and those of **special sense.** This is important in that the exact spot that is affected can be determined by the symptoms, since cerebral localization is now a fairly exact science. The **motor areas** are grouped around the fissure of Rolando, so that in motor paralysis of central origin the exact location of diseased area is made possible. This area is also sensory to a certain extent and has been called sensori-motor, since it has been determined that sensory fibers from the skin terminate in this area. The lower part of the Rolandic area is the motor center of the neck, head and face, the middle portion, for the arm and that portion around the upper part of the fissure, is the motor center for the leg and trunk. These motor centers control the action of the muscles on the opposite side of the body, but if the hemorrhage involves the pons before the fibers of the facial decussate, the muscles on the same side of the face will be paralyzed, this constituting a crossed paralysis. The **auditory area** is located by Ferrier in the upper part of the central sphenoidal convolution. That for **vision,** in the occipital lobe, while the **speech** center is supposed to be in the frontal lobe on the left side which is called, in honor of its discoverer, Broca's convolution.

These various areas are connected with the parts of the body by certain tracts. The motor tracts are divided into the direct or voluntary, and indirect. The direct motor tract originates from cells in the Rolandic area, the fibers from which converge into a narrow band that pass through and form the posterior part of the internal capsule.

They pass on into the pons Varolii and medulla, at the latter point most of them cross over to the opposite side forming the pyramidal tract. While in the medulla, some fibers cross to the nuclei of certain of the cranial nerves. The fibers that do not cross in the medulla form the direct pyramidal tract. The indirect motor tract contains fibers that pass into the internal capsule, that are in relation with those of the direct tract but in addition, connect with the optic thalamus. They pass on through the cerebral peduncles into the pons. They then cross the median line into the cerebellar peduncles and thence into the cortex of the cerebellum. This tract is concerned in co-ordination of the muscles performing the finer movements of the body and the automatic action of these muscles as in walking, or the use of the hands in the playing of musical instruments, etc. The **direct motor tract** is concerned in all the voluntary movements and Dana says that when the anterior horn cells of the cord are cut off from it by disease, there is a special form of paralysis. The **sensory tract** is also divided into a direct and an indirect. The direct tract includes the fibers that carry impulses from the skin. These pass into the posterior spinal ganglion, across the **posterior** columns of the cord, into either Gower's tract or the anterior ground bundle, the medulla and pons and finally into the optic thalamus. It then sends out terminal branches to the cortex that forms sensory areas. The indirect sensory tract, according to Dana, carries impulses which originate in muscles, joints and viscera. These pass through the posterior roots into the spinal cord, thence up the posterior column of the cord on the same side. They decussate then to the opposite side and go to the cortex of the cerebellum, while others terminate in the red nucleus and the optic thalamus. Still others pass up into the cells of the column of Clark, thence through the direct cerebellar tracts to the cerebellum. Dana says: "The direct sensory tracts carry for the most part, the sense of touch, pain and temperature. The indirect sensory tracts are concerned with sensation from the muscles and joints which have to do with co-ordination and also with visceral sensation. It is through the indirect sensory and indirect motor tracts that the automatic and psycho-reflex acts are performed." These tracts are of interest to us in that hemorrhages, emboli and diseases from other causes, affect them and thus the location of the disorder can be determined.

The brain is surrounded by **three membranes** which are named from their structure and supposed function, the **dura mater, arachnoid** and **pia**

mater. The **dura mater** is the outermost covering, forms the periosteum of the bones of the skull, divides into septa which separate the cavity into compartments, and forms the venous sinuses of the skull. It is the strongest of the membranes and perhaps the most sensitive. Nine-tenths of its sensory nerves are derived from the fifth cranial, while the remaining posterior portion is supplied with sensation by the pneumogastric.

The **arachnoid** is a thin, fibrous, non-vascular, spider-web-like membrane that lies between the dura and the pia mater. There is a space between this layer and the dura mater called the sub-dural-arachnoid space, and the cavity thus formed resembles a serous cavity, since it is lined with epithelium. The space between the arachnoid and the pia mater is called the sub-arachnoid cavity. These spaces contain a serous fluid called the cerebro-spinal fluid. This layer is non-vascular and has no sensory nerves.

The **pia mater** is the nourishing layer as its name indicates, since it supplies the outside of the brain with blood. It is continuous with the pia mater of the spinal cord and is in close relation with the folds of the brain. From it are formed vascular folds from which is derived the choroid plexus that supplies some of the ventricles of the brain. Dana says that it has **vaso-motor,** but no sensory nerves.

The **functions** of these membranes are: first, to furnish a cavity that contains the cerebro-spinal fluid by which the intra-cranial pressure is regulated; second, to serve as a protection against injury, congestion or other diseases of the brain, the membranes being very sensitive and, third, to furnish nutrition and blood to the brain. In nearly all **headaches** that are intra-cranial, the pain is the result of pressure against these membranes from congestion of the brain. Prolonged headache on one side is a prodromal symptom of apoplexy, it being the result of increased amount of blood and increased blood pressure. These membranes may be stimulated by other causes such as toxic material in the blood and by growths producing direct pressure. The intra-cranial type of headache is characterized by increase of pain when the blood pressure is increased as in stooping, or by exertion by which the action of the heart is increased, which aggravates the congestion. Lesions that produce congestion of the meninges of the brain or increase the amount of blood in the cranial cavity by obstructing the drainage, inhibit the vaso-motor centers or increase the heart's action, will produce headache. Over-

use of the centers in the brain will produce congestion which is frequently followed by headache. This is best illustrated by cases of weakness of the eyes or overuse of them, invariably producing headache. Riding on the train, especially if the patient attempts to read or watch the near-by passing objects, will increase the activity of the centers for sight and thus produce a congestion. The painful effect is explained by the fact that this abnormal amount of blood produces a painful pressure on the coverings of the brain.

The subject of the blood supply of the brain's membranes and the conditions affecting it are of vital importance to the osteopathic practitioner. Upon the disturbance of this depends most disorders of the brain, that is, such disorders as arise from causes without, rather than from causes within the cranial cavity, although in some cases there may be abuse of function or pressure of the skull from injury. The arterial blood is derived from the **external** and **internal carotid,** and the **vertebral** arteries.

The **meninges** are supplied almost entirely by the external carotid. The **posterior meningeal** branch, which comes from the occipital, supplies the dura mater of the posterior fossa of the skull. The **ascending pharyngeal** gives off meningeal branches that are distributed to the dura mater in the posterior and middle fossæ of the skull. The **internal maxillary** artery, through its largest branch, the **middle meningeal,** supplies the greater part of the dura mater.

Perhaps the most important branches of this artery from a pathological point of view, are those that supply the **Gasserian ganglion.** It is possible that the branches which enter the Gasserian ganglion also supply the different divisions of the fifth cranial nerve. The vaso-motor impulses that supply these branches are derived, so far as can be determined, from the upper thoracic spinal cord and pass by way of the superior cervical ganglion and its internal branches to the carotid plexus, which gives off secondary plexuses that surround its branches. Judging from clinical observation, a lesion along the course of these nerves will produce a vascular disturbance in the parts supplied by the above named arteries. Some seem to doubt the existence of vaso-motor nerves n the blood-vessels of the brain. Dana says the blood-vessels of the brain probably have vaso-motor nerves. Landois makes a similar statement while Langley claims that they are not demonstrated physiologically but are histologically. Whether they have or not, undoubtedly cervi-

cal lesions produce constriction and dilatation of the blood-vessels and I believe these results are through vaso-motor nerves. At least it has been demonstrated that the meningeal vessels have nerves. From this it follows that any lesion that inhibits or stimulates the passing of vaso-motor impulses to the meningeal branches of the external carotid, or especially to the branches that supply the Gasserian ganglion, will produce vascular disorders in the above named parts. It isn't so much a question that spinal lesions affect the circulation of the brain as how it affects it, the first being conceded, the second, not clearly demonstrated.

The **internal carotid** artery supplies the anterior and upper part of the brain. Its branches that have to do with supplying the brain are the **anterior meningeal, posterior communicating, anterior cerebral, middle cerebral** and **anterior choroid, Gasserian, cavernous** and **pituitary.**

The **meningeal** branch of the internal carotid supplies the dura mater of the middle fossa and anastomoses with the small and middle meningeal from the internal maxillary.

The **posterior communicating** artery comes from the internal carotid near its termination. It supplies branches to the optic tract, the interpeduncular region, crus cerebri and the uncinate convolution of the brain. It also sends a branch to the optic thalamus.

The **anterior cerebral** artery supplies the greater part of the anterior portion of the brain and the basal ganglia. It gives off large branches to the **frontal** and **parietal** lobes. The **anterior communicating** artery is a transverse trunk that connects the two anterior cerebral and is of interest in that the **ganglion of Ribes** is on this artery. The **ganglionic** branches supply the caudate nucleus. The **commissural** supply the corpus callosum. The **cortical** or hemispherical branches of the anterior cerebral, supply the olfactory bulb, the frontal convolutions, the marginal convolution, the lamina cinerea and the quadrate lobe. Undoubtedly these arteries have vaso-motor nerves that are derived from the cervical sympathetic, since lesions of the cervical vertebræ affect this part of the brain. Since the glanglion Ribes is in such close relation with the anterior cerebral artery, it certainly seems reasonable that it has something to do with its innervation, that is, it furnishes either vaso-motor or trophic impulses to it, or probably both.

The **middle cerebral** is the larger of the two terminals of the internal carotid, and divides into the cortical and central branches. The **cortical** branches are given off while the artery is in the fissure of Sylvius in re-

lation with the island of Reil. These branches supply the frontal, parietal, the external part of the occipital and the temporo-sphenoidal convolutions. They anastomose with each other to only a slight degree. They pass to the surface of the cerebrum at almost a right angle to the surface, hence few would be injured in a stab wound. The **central** or ganglionic branches are of pathological interest in that they are the ones most frequently ruptured in **apoplexy.** These vessels have received various names. Cunningham divides them into the internal and external striate arteries. The **internal,** supply the internal capsule, and the anterior portions of the caudate and lenticular nuclei. The **external** are divided into the **lenticulo-striate** and the **lenticulo-optic.** The **lenticulo-striate** supply the lenticular nucleus, internal capsule and the caudate nucleus. One of these striate arteries, on account of the frequency of rupture has been called by Charcot, the **"artery of cerebral hemorrhage."** The **lenticulo-optic** supplies the lenticular nucleus and terminates in the optic thalamus. The nerve supply of the middle cerebral, comes from the carotid plexus which surrounds the internal carotid artery and sends off branches with each division. In hemiplegia, lesions of the upper cervical vertebræ are invariably found, which in itself is pretty good proof that there is some connection between the neck and the middle cerebral artery. The better proof is that correction of these lesions is quite frequently followed by marked improvement unless the hemorrhage has been a severe one. The nutrition of the walls of these arteries is also affected in hemiplegia, partly as a result of the neck lesion and partly as a result of other causes, especially dissipation and hard mental strain. On account of the fact that these arteries do not anastomose, the absorption of a blood clot is a slow process. Also if the clot is not absorbed within a short time, **softening** or degeneration of the brain tissue will ensue on account of lack of nutrition.

The **anterior choroid** artery helps to form the choroid plexus and supplies the optic tract, crus cerebri the hippocampus major and the internal capsule. It receives its nerve supply from the plexus around the internal artery. The **Gasserian** branches are small twigs that supply the **Gasserian ganglion.** The **cavernous,** supply the walls of the cavernous sinus and the **third, fourth, fifth** and **sixth** cranial nerves. This is of importance since it helps to explain certain disorders of these nerves resulting from central and spinal lesions. Derangement of the cervical sympathetic will in all probability affect these blood-vessels, and thus

produce disorders in the above named cranial nerves on account of this derangement. The **pituitary** branches supply the pituitary body. The function of this body is not well known but it is supposed to furnish an internal secretion that increases the contraction of the heart and arteries, and influences the metabolism of the bones and nervous system. Experimentally, its removal in a dog produces (1), diminution of body-temperature; (2), loss of appetite and lassitude; (3), muscular twitchings, tremor and spasms; (4), dyspnea. (Raymond). Lesions of the neck produce in some cases, similar effects and possibly through disturbances of this body.

The **vertebral** artery with the basilar, give off the **posterior cerebral,** the **posterior inferior, anterior** and **superior cerebellar, posterior meningeal, transverse** or pontal and the **internal auditory.**

The **posterior cerebral** artery divides into central and cortical branches. The **central,** supply the optic thalamus, the walls of the third ventricle, crus cerebri, choroid plexus and the corpora quadrigemina. The **cortical** branches supply the occipito-temporal, uncinate, and the lingual lobes. Although the blood does not pass directly from the vertebral to the posterior cerebellar, it going through the circle of Willis, it seems that the nerve filaments that surround the vertebral pass on to the branches of the basilar. Clinically, an impairment of the vertebral arteries will affect the eyes. One explanation is that the blood supply of the cells of origin of the optic nerve is affected by such a lesion through disturbances of the vertebral artery from spinal or other lesions.

The **posterior inferior cerebellar,** is the largest branch of the vertebral. It supplies the vermiform process, medulla, fourth ventricle, the cortex of the cerebellum and furnishes branches to the choroid plexus. Upon the condition of this artery depends the nutrition of the above named parts. The condition of the artery is determined by the amount of nerve impulses passing to it. Since they come from the vertebral plexus and this is subject to injury in lesions of the upper vertebræ, it follows that such lesions produce disorders of the medulla and cerebellum.

The **anterior cerebellar** is a branch of the basilar. It is distributed to the front of the cerebellum and sometimes sends a branch to the pons and the crus cerebelli. The **superior cerebellar** supplies the valve of Vieussens, pineal gland, choroid plexus, optic lobes and the cerebellum. These branches of the basilar, receive their nerve supply from the vertebral plexus and as pointed out above, would be affected by a lesion in

the upper cervical region. The posterior meningeal, is a small branch of the vertebral that supplies the bone and dura mater of the posterior fossa of the skull. The transverse or **pontal** branches of the basilar, supply the pons and the adjacent parts of the brain. The **auditory** branch accompanies the auditory nerve and supplies it and the internal ear. These branches are also subject to impairment from neck lesions on account of the innervation. *Morris in his summary of the cerebral arteries says: "It will be seen therefore, that the **middle cerebral** supplies the motor region, both central and cortical, except a part of the leg centre. It also supplies the region of the cortex that subserves cutaneous sensibility, the cortical auditory center and in part the higher visual centre. It likewise supplies all the cortical regions concerned in speech processes in the left hemisphere. The anterior cerebral supplies only a small part of the motor region; namely, the part of the leg centre that occupies the paracentral lobule and the highest part of the ascending frontal convolution. The posterior supplies the visual path from the middle of the tract backwards, and the half vision in the occipital lobe. It supplies also the corpora quadrigemina and the sensory part of the internal capsule."

The **veins** of the brain are peculiar in that they form **sinuses** and have few, if any muscle fibers in their walls. The meningeal veins form a net-work in the dura mater with free anastomosis. They do not follow the arteries so closely as do other veins, and do not increase in size as they approach their terminations. The veins of the cortex ascend and empty into the **superior longitudinal sinus.** Gowers says: "The course of the surface veins is important because it helps to explain the frequency with which clots form within them. Elsewhere the blood from ascending arteries passes into descending veins, so that the feeble pressure through the capillaries is supplemented by the influence of gravitation." On account of ascending arteries emptying into ascending veins it is pointed out that the pressure would be lessened to such a degree that the flow would be retarded in both veins and arteries. Gowers further says: "Moreover, in the erect posture, the anterior part of the longitudinal sinus has also an ascending course, while the trabeculæ that occupy the lumen of the sinus must offer some hindrance to the movement of the blood. These circumstances help us to understand the readiness with which clots form in the cortical veins and longitudinal sinus, when other circumstances favor the coagulation of the blood."

*Human Anatomy, Morris, p. 533.

The **central** veins enter into the sinuses. There are fifteen sinuses of which the important ones are, the **longitudinal,** the **lateral,** the **straight,** the **petrosal,** the **occipital,** and the **cavernous.** They eventually empty into the **internal jugular vein.** The various cerebral veins have no valves and few, if any muscle fibers in their walls.

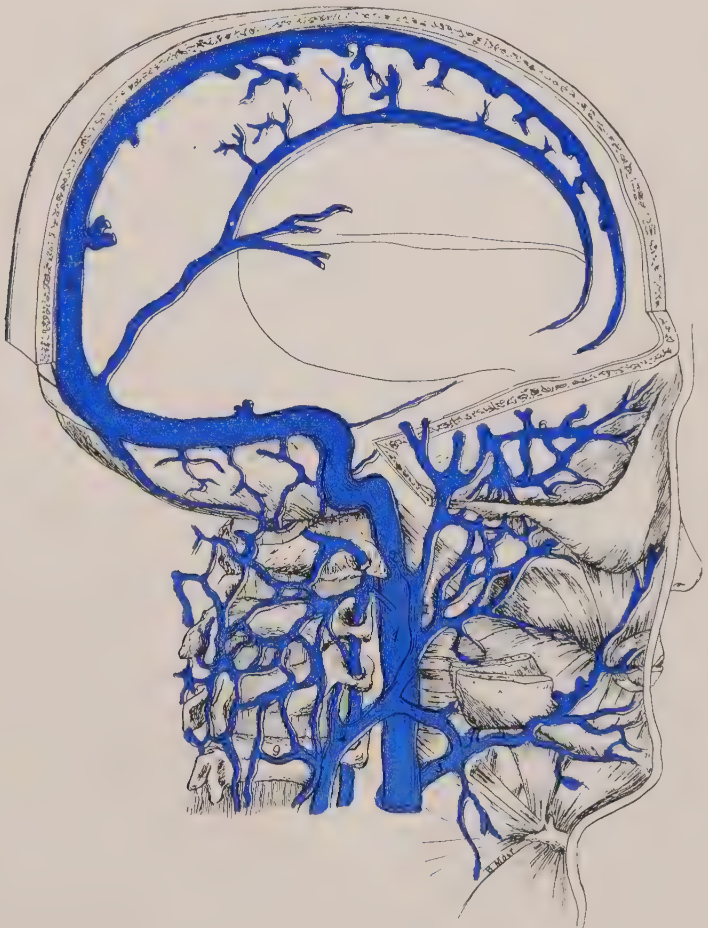

FIG. 150.—Showing the veins of the neck and head. (After Quain). Note that muscular contractures in the neck would obstruct the drainage of these parts.

Some of these sinuses communicate with the veins that are external to the skull. "Veins from the nose enter the anterior extremity of the superior longitudinal sinus." The facial vein communicates with the cavernous sinus. On account of these outlets, **epistaxis** will often relieve a congestive headache since a great part of the blood comes from the cavernous and superior longitudinal sinuses. These sinuses when engorged with blood, exert a painful pressure on the meninges which are quite sensitive and thus the ache is produced. Lesions of the neck tend to obstruct the **jugular vein through tightening of the tissues.**

In such cases the blood retained in the sinuses becomes very dark in color and ladened with toxic materials.

The **veins of the cerebellum** empty into the lateral, occipital and petrosal sinuses and the great vein of Galen. Those from the **pons,** empty into the basilar and cerebellar veins and into the superior petrosal sinus. The veins of the **medulla** drain into the anterior and posterior median and radicular veins which empty into the occipital, inferior petrosal and basilar sinuses. Most of these veins are continuous with those of the upper part of the spinal cord. It does not take a very great force to materially obstruct these veins since the pressure is not so great as in other parts of the body. Contracture of the muscles of the neck and other cervical lesions are the most important of active causes. The grey matter of the brain is very vascular, it ranking "in richness of blood supply with the lungs and liver."

Disturbances of the function of the brain are indicated by many signs and symptoms. Some of these are dependent upon other causes, hence are not diagnostic of organic disease, while others are fairly constant and can be relied upon in the diagnosis of the disorder of the brain. These indications of cerebral diseases vary in degree from a slight headache to profound motor paralysis. The disorders themselves vary in degree from a slight vascular change to extensive destruction of the brain tissue as in softening. On account of the importance to the practitioner of a knowledge of the various indications of cerebral disease, we will consider in a general way the phenomena that are at least suggestive of such disease.

A child with a very small head, a condition called **microcephalus,** has ordinarily an undeveloped brain. Such a condition will be characterized by idiocy, usually a vicious disposition, some form of motor paralysis and other indications of non-development of, or pressure on, the substance of the brain. These symptoms of course, vary with the

amount of pressure and the degree of development. Ordinarily, a history of a very hard labor or instrumental delivery is to be expected in such cases. Although microcephalus is regarded as a congenital disorder, I am of the opinion that **at least some cases result from injury to the neck of the child at or immediately after birth.** The fontanelles close early and the ossification of the cranial bones is completed soon after birth. The above signs and symptoms occurring in a child, are diagnostic of disease of the brain, the particular form of disease being **non-development** of, or **pressure** on, the brain substance.

The opposite condition, that is enlargement of the head, is also indicative of disease of the brain. This is called chronic **hydrocephalus.** Most of these cases begin at or soon after birth, hence the increase in size of the head is of diagnostic importance only in the young. If the head gradually increases in size from birth, the fontanelles and sutures refuse to close, if the forehead bulges and pressure shows fluctuation, the case in all probability is one of hydrocephalus. The face does not grow in proportion to the skull and as a result, the child's face has a triangular appearance. As this condition progresses, the growth of the body is retarded, the child does not learn to walk, is unable to support the head and pressure symptoms soon develop, the symptoms of which vary from strabismus to convulsions. This enlargement of the head is due to the gradual accumulation of serous fluid in the ventricles of the brain, which, in my opinion, is more often the **result of injury** to the **child's neck at birth,** than of all other causes combined. The above mentioned neck lesions possibly produce this condition through irritation of the meninges or obstruction of the foramen which connects the serous cavity of the brain with that of the spinal cord.

Unilateral enlargements of the head are suggestive of **exostoses** from injury, but not necessarily of diseases of the brain, or of the mental development of the person. Only in a general way are the various prominences of the head indicative of the condition of the part of the brain in relation.

Impairment of the **mental condition** is suggestive of brain disease, which may be due to congestion of a localized area, softening of the brain tissue or pressure from a tumor or depressed bone. In chronic cases, **insanity** invarably carries with it the idea of softening of the brain, which condition is practically incurable. In children, idiocy, drooling from the mouth, non-development of the teeth, or early decay and crumbling

of the teeth soon after they are ruptured, inability of the child to learn to talk or control the movements of the limbs there being a spasticity, are all indicative of disease of the brain. In such cases the child is usually overgrown, nutrition good, and ordinarily the child has a craving for sweetmeats, and organic life is usually good and the child often escapes many of the diseases of infancy and childhood. Little's disease is the name applied to such cases.

Complete unconsciousness, if it occurs suddenly, is indicative of

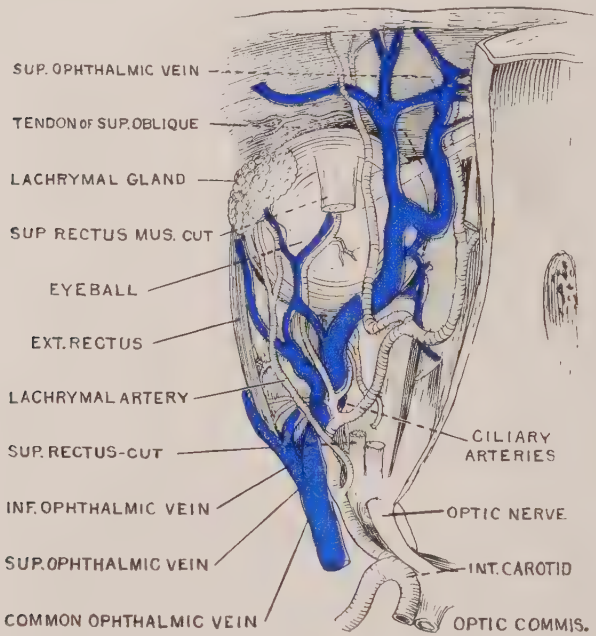

Fig. 151.—Showing the veins of the eye. Since they also drain the appendages of the eye, any affection of these veins would affect both. (After Morris.)

apoplexy. If it comes on gradually, it is usually the result of pressure, or acute toxic conditions of the blood. Cerebral anemia, whether from neck lesions, hemorrhage, or from diseases of the heart, often bring on a gradual unconsciousness. **Stupor** is often suggestive of cerebral disorder especially if the patient sleeps a great deal and is hard to awaken out of

slumber. The stupor may be indirectly due to disease of the viscera which have to do with purifying or forming the blood, and the effect on the brain being secondary as a result of the toxemia. **Coma** is often the result of injuries to the head that produce hemorrhage or concussion of the brain substance. It also may be the result of certain poisons. In diagnosing these various conditions of coma, the odor of the breath, condition of the pupil, character of respiration, urinary changes, color and the condition of the skin, the pulse and temperature should be taken into consideration. **Delirium,** consists of mental excitement usually accompanied by hallucinations. It is most frequently the result of a toxemia from alcoholism and fever. **Dementia** is indicative of organic disease of the cerebral cortex.

Convulsions that are epileptiform or chronic in character, are usually due to disease of the cerebral cortex. Hare says: "The clonic variety of convulsions are represented by idiopathic, traumatic, reflex and syphilitic epilepsy, hysterical convulsions of an epileptic type, uremic convulsions and those convulsions that arise from the presence of growths or other sources of irritation in the cerebral cortex." It may be added that some forms of neck lesions produce irritation of the cortex through derangement of the circulation. In Jacksonian epilepsy, the convulsions are local with progressive extension to adjacent muscles with little or no involvement of the mind. This form is usually caused by a pressure either of a tumor, or fracture of the cranium. Spasms that are general point to diseases of the brain. **Forced movements** and **intentional tremor** also point to a central origin. **Vertigo** is usually suggestive of a vascular disturbance of the brain and is only a symptom. It is a symptom of disease of the labyrinth, cerebellum, cerebellar peduncle and of general anemia of the brain. In **disorders of the heart, vertigo** is often found as a complication. Vertigo is also a premonitory sign of an epileptic attack and of disseminated sclerosis. All the forms of vertigo are primarily dependent upon the vascular changes in, and condition of, the blood-vessels of the brain. **Persistent headache** in one localized area of the head, is symptomatic of congestion which may lead to apoplexy. Pressure from other causes such as tumor, fracture with displacement of a portion of the cranial vault, thrombosis and congestion of the meninges produce headache, and therefore these things should be considered in determining the cause. Headache, like vertigo, is only a symptom of disease and, like it, is dependent on changes in the quality and quantity of

the blood in the brain tissue. **Headache** may be the result of congestion, anemia or toxemia of the brain. The forms of headache that point to disease of the brain are those that are localized and prolonged, moving about or stooping making it worse; and those accompanied by vertigo, spasm, affections of the eye, such as amaurosis, ptosis and ordinarily those accompanied by vomiting as in tumors of the brain. This particular type of headache can partly be diagnosed by the elimination of causes outside of the skull that are responsible for many cases of headache.

The condition of the **pulse** is in some cases, suggestive of brain disease. If the medulla or the center for the pneumogastric nerve is involved, there will always be some cardiac disorder. In tumors of the brain, cerebral abscesses or pressure from other causes, the pulse rate is often lowered, it sinking to as low as thirty beats per minute. In some cases this is so marked that the temperature may be quite high and still the pulse rate slow. Certain disorders of respiration come from brain disease, especially affections of the medulla in which are located the respiratory centers. The **Cheyne-Stokes** respiration occurs in cases in which there is pressure on any part of the mechanism which controls respiration, such as hemorrhages, tumors and aneurisms. In this respiration, the breaths become more rapid and deeper until they reach a climax, which is followed by a stage of apnea. The cycles continue for a short while when the patient either gets very much better or it terminates fatally, which is the usual ending.

Apoplexy is diagnostic of disease of the vessels of the brain. This disease is usually one of hardening of the blood-vessels, on account of which there is loss of elasticity, so that any change of pressure more readily affects these walls, thus producing rupture with its consequent hemorrhage. This rigidity of the arteries or **atheromatous** condition, is the result of alcoholism, high living, excesses, kidney disease, mental strain and bony lesions of the neck. Church says: "The strongly acting heart drives the blood column through the rigid aorta and carotids and its full force falls upon the arteries arising from the Circle of Willis. These are of comparatively small caliber and, not having outlets by anastomosis, oppose a dead wall of resistance to the directly received cardiac impulse. Surrounded in turn by parivascular spaces and not supported by firm parenchymatous tissues, their walls weaken by age or infection and yielding at numerous points to the formation of sacular dilatations, arterial rupture naturally follows." A person is said to

have the "apoplectic build," when the **complexion** is **florid,** that is, the superficial capillaries of the skin quite markedly dilated, is **obese** and **short of stature.** In such people hemorrhage in the brain may follow from exertion or from emotional causes.

Hemiplegia is diagnostic of disease of the brain. It usually results from **hemorrhage,** but may result from pressure from other causes, such as a tumor, embolus, and depression of the cranial vault. The degree of hemiplegia is fairly indicative of the degree of cerebral disorder. If the paralysis is only partial, it suggests a hemorrhage that is not extensive, but from which the patient usually recovers. If the hemorrhage is extensive, there will be complete paralysis, which is usually permanent. The hemiplegic state is characterized by sensory, as well as motor disturbances of the lateral half of the body. In the upper extremity, the flexors draw the fingers in the palm of the hand, flex the wrist, pronate the arm and the elbow is fixed at a right angle. The arm is carried close to the body and there is to all intents and purposes ankylosis of the joints. The hand is cold a great deal of the time, the skin like that of a baby, and a clammy perspiration is present. In the lower limb, there is loss of movement so that the leg is dragged and the toe of the shoe is worn off on account of the dangling of the foot. When the patient attempts to take a step, the body weight is thrown forward and the toe describes an arc around the other foot. **Contractures** sometimes develop which are most common in the tendons behind the knee. If there is crossed paralysis, the face on the same side as the lesion, is paralyzed. In ordinary cases, only the lower half of the face is impaired, which affects the mouth, nose and chin, particularly the lips. This differs from Bell's paralysis in that in the latter, the upper as well as the lower part of the face is involved.

Some cases of **monoplegia** are the result of disease of the cortex. The seat of the lesion is in the internal capsule in such cases. **Hemianesthesia,** which is partial or complete, comes from a central cause. If it comes on suddenly, it is suggestive of apoplexy but usually the condition is associated with motor paralysis. In **disseminated sclerosis,** hemianesthesia is sometimes found. In cases of apoplexy, Church says: "Only in those cases in which the lesion destroys the sensory pathway in the posterior third of the posterior limb of the capsule do we have persistent hemianesthesia corresponding to hemiplegia."

Ataxia may be the result of disease of the brain as is demonstrated in cerebellar ataxia. Oppenheim says diseases of the sensory centers

and conducting tracts may also cause ataxia in the extremities of the outside of the body.

Ptosis is indicative of disease of central origin especially if it comes on suddenly. Back of this are found neck lesions that seem to be responsible for the effect, in that correction of them in some cases seen by the writer, resulted in the curing of the disease within a short time after the treatment was given. In these cases the lesion affected the vasomotor or trophic nerves to the center of the brain, in which is located the origin of the occulo-motor nerve. Ptosis may be the result of causes other than brain disorders, but if it is chronic and accompanied by hemiplegic symptoms, and if it comes on suddenly, the chances are that it is of central origin.

Conjugate deviation of the head and eyes is quite indicative of cerebral disease. This deviation is usually toward the side of the lesion and is most marked in the beginning of the hemiplegic state. If the hemorrhage is quite low or in the pons, the eyes will be turned away from the lesion while the head will be drawn in the opposite direction.

Disturbances of vision such as atrophy of the optic nerve, optic neuritis and choked disc, are usually the result of central disease. **Hemianopsia** also results from central lesion. The rolling of the eyes or **nystagmus**, occurs in certain forms of brain disorder. Very marked prominence of one eye is suggestive of a cerebral tumor which is forcing the eye out into prominence. Often the size of the pupil is affected in brain disorders. In tumors, the pupil is usually contraced.

Certain disorders of the speech such as **aphasia** is indicative of disease of the brain. Aphasia consists of an impairment of the ability to express thoughts or ideas with words or signs and to comprehend spoken or written language. There are different forms of this which depend upon the extent of the lesion. Broca's convolution, is usually the seat of the lesion in this disorder. A slow, scanning speech is characteristic of Friedreichs' ataxia. A hesitating, halting speech in which the patient mutters and mumbles in an indistinct and blurred manner, is found in paretic dementia. In a very indistinct speech in which the patient has trouble in pronouncing the letters in which the lips are used, disease of the medulla is to be expected. This is called glosso-labia-pharyngeal paralysis.

Agraphia is the loss of power to write his own ideas but can copy perfectly. The insertion of wrong words, that is, when a patient attempts

to name an object and is conscious of having called it wrongly, is called **paraphasia.** These conditions are indicative of some central lesion in cases organic in character and in others, only functional from vaso-motor disturbances. If a patient has a staggering gait, intention tremor, if he reaches for an object and the hand moves all around it and finally the object is suddenly seized, if there is nystagmus, slow, scanning speech called a syllabic speech, it points to disseminated sclerosis. If vomiting occurs that is independent of the taking of food and is most marked in the morning and there are other indications of cerebral disorder such as vertigo, chronic headache, slow pulse, choked disc, it points to disease of the brain.

In the average case of brain disorder, lesions are present in the neck that act as predisposing or as exciting causes. The explanation is that in the neck are centers that regulate the amount of blood that passes to the brain and these vaso-motor centers are affected by lesions of the upper cervical vertebræ. Not only is the arterial supply to the brain interfered with, but the drainage obstructed by the contracture of tissues with which the veins are in relation. Another point to be considered in the production of cerebral disorders especially functional disturbances, is the condition of the **heart.** If the heart is irritated, too much blood will be forced into the cranial cavity and thus produce a cerebral congestion. This condition is the more important, if there are neck lesions that affect the vaso-motor nerves that govern the cerebral circulation.

Disease of the **kidneys** predispose to brain disorders, by affecting the nutrition of the blood-vessels. Worry, over-work or prolonged application to any one subject, tend to produce vascular changes in the brain that often become pathological. Each compartment of the brain has its function to perform. When it is performing its function, that is, when the center is active, more blood is sent to the part. If the part is over-worked, the congestion may become pathological and the function of the part be lost or suspended. Many a case of **insanity,** is the result of **overuse** of a **certain part** of the brain to the exclusion of other parts, and degeneration of the part is the result. The cerebral circulation should be equalized by using the different parts, that is by changing the thoughts and thus shift the activity from one part to another. For example, a student along any line should devote a part of his time to relaxation of the mind by change of subject or by physical exercise in which there is competition, so that the mind is taken entirely off from the persons'

hobby. By doing this every day, the mind gets its rest and the cerebral circulation is the better equalized. It is all the more important in cases in which the circulation through the brain is impaired by cervical or other lesions. The writer's hobby is that **all parts** of the **body are in some way connected with the spinal cord.** This includes the **brain.** Spinal lesions impair this connection, hence predispose to cerebral disease.

THE EYE.

The **eye,** the most important of the organs of special sense, is of pathological interest in that it is often diseased and particularly in that it is a fairly accurate index as to the general physical condition. If a person is exhausted, the condition is at once manifest in the eye. Sickness and suffering are depicted in the eye. On account of the eye being such a reliable index as to the condition of the body, the various pathological signs and symptoms of which the eye is a part, will be taken up separately with the idea of anatomically explaining these effects.

A localized prominence of one eyelid is indicative of a **Meibomian cyst.** The Meibomian or tarsal glands, occupy the middle of the tarsal cartilages. They empty their secretions by means of slender ducts that extend to the inner and anterior edge of the eyelids. The openings of these ducts, there being about thirty in each lid, are characterized by minute apertures arranged in rows. A stopping of these ducts will lead to the formation of a retention cyst, called a Meibomian cyst. They can be removed by manipulation by which the tumor is grasped and compressed. In none of the cases treated by the writer was it necessary to resort to an operation. They are harmless but mar the beauty of the eye.

A **red, angry** condition of the inner surface of the lid is diagnostic of **conjunctivitis.** This condition is the result of many causes of which the lesions of the neck are the most important. These lesions, as pointed out before, affect the eyelid through the innervation of the blood-vessels. The vaso-motor impulses that innervate the blood-vessels of the eyelids are derived from the spinal cord, pass up through the superior cervical ganglion, thence along the cavernous plexus to the ophthalmic artery and its branches, some of which supply the eyelid. Contractures of the neck muscles will in a very short time, produce a redness of the eyelids. This is called "catching cold in the eye" but really it should be called "contracture of the muscles of the back of the neck."

A thickened condition of the eyelids is suggestive of disease of the hair roots, especially if there is marked redness and a turning in of the eye-lashes. In some cases, this reddened, thickened condition of the lid is due to gonorrheal infection.

Twitching of the **eyelids** is symptomatic of **nervousness, chorea, histrionic spasm** and disorders of the third and seventh nerves. Unless the condition forms a part of a general nervous affection, neck lesions are invariably found in such cases. Such lesions affect the nutrition of the muscles and nerves involved and thus render them more irritable. Eye strain, is an important cause in children, of twitching or spasmodic winking. It is suggestive of weakness of the eyes or some refractive disorder. **Blepharospasm** is nearly always the result of lesions of the upper cervical vertebræ. In nervous, hysterical people, a quivering of the eyelid is a fairly constant symptom. In feigned unconsciousness, this quivering of the lids is nearly always present. Some forms of spasmodic contraction of the lids are due to central lesions.

Ptosis is nearly always the result of a lesion of the brain. Back of this are lesions that impair the circulation to the brain and thus are responsible for the paralysis.

A **sty** or **hordeolum**, seems to be the result of infection of a hair follicle. If the dead root of the hair is removed at once, the sty can often be aborted. Vascular and nutritive disorders of the eyelid, predispose to their formation. These result from overuse of the eye, congestion of the brain and lesions in the upper cervical region especially at the second and third vertebral articulations.

A **puffy** condition around, but especially below, the eye is suggestive of either heart or kidney disease. The explanation of the phenomenon is not very clear but it is supposed to be due to the character of the tissues of this part, they being loose and flabby. For the same reason an injury to any part in relation, will cause a black eye, on account of the extravasation of blood into these tissues.

Dark rings under the eyes are due to exhaustion of the patient. In the female they are indicative of menstruation. They are not diagnostic of any special disorder, but are suggestive of female weakness. These rings are most pronounced in the dark complexioned.

The escape of tears is the result of excessive secretion, stopping of the lachrymal ducts or to weakness of the eye so that any exciting cause produces an increase of secretion. If the eyes "water" on exposure to the

wind, it is almost diagnostic of **weakness** of the eyes. Lesions of the neck affect the lachrymal gland and if irritative, increase the amount of tear secretion.

A **flattened eyeball** is diagnostic of far sightedness or **hypermetropia.** A bulging, convex eyeball is indicative of near sightedness or **myopia.** These conditions are usually easy to diagnose if at all typical but if only slightly marked, they may be overlooked.

If the eyeball is red and inflamed, or if it is "blood shot," it is indicative of conjunctivitis or a hemorrhage from rupture of some of the blood-vessels of the eyeball. The catching of cold in the eye, will produce an engorgement of the small vessels to such an extent that it becomes intensely red in appearance. Rupture of the blood-vessels, results from trauma or intense straining as in a paroxysm of whooping cough. In such cases there is extravasation of blood into the tissues around and in the eyeball which gives it the extremely red, angry appearance. Usually the eye clears up in a few days but in the worst cases it may take several weeks. If there is only an engorgement and no rupture of the vessels, the neck lesions are the most important causes and by applying the proper treatment to the neck, the congestion can be relieved in a short while.

If there is a localized area of engorgement of the superficial vessels of the sclerotic coat, with a "peculiar fleshy mass of hypertrophied conjunctiva" it is called a **pterygium**. It most commonly starts from the inner canthus and gradually advances across the eyeball in the horizontal meridian. It sometimes reaches and crosses the cornea and pupil, in which cases the eyesight is affected. Aside from irritating particles that act as exciting causes by producing congestion, the neck lesions, especially those of the axis, are the important causes of pterygium in that they inhibit the passing of the vaso-motor impulses from the spinal cord to the blood-vessels of the eye. These impulses seem to originate in the upper part of the thoracic spinal cord and pass to the eye by way of the cervical sympathetic ganglia and the ascending branches that form the cavernous plexus. This plexus innervates the **ophthalmic** artery and all its branches hence the vessels of the eyeball get their vaso-motor supply from this source. Ordinarily this disorder is treated by attempting to counteract the effect by ligating or removing the vessels with the fleshy-like mass. Some cases appear to be cured by the treatment but in many, the pterygium re-appears since the primary cause, that of the disordered nerve supply to the arteries, is still active.

The **size** of the **pupil** should be considered in the examination of the eye in brain and spinal cord diseases. If it is contracted, it is indicative of congestion of the iris, paralysis of the fifth cranial and the sympathetic supply to the eye, cerebral tumor (early stages), hemorrhage of the brain, and spinal cord disease especially the part above the third dorsal segment. Certain drugs and poisons, produce contraction of the pupil and should be borne in mind when making a diagnosis. Opium and morphine, when used in large doses, will produce marked contraction of the pupil to the extent of pin-point contraction. If the pupils are large, it is suggestive of ocular disease such as glaucoma, irritative lesions of the upper part of the spinal cord, anemia of the brain, syncope, extensive brain lesions, tumor of the brain, especially the later stages, and of fright, neurasthenia, a depressed nervous condition, and emotional disturbances. It also occurs in forced respiration, vomiting and from the use of certain drugs called mydriatics. Cocaine and atropine and its allied alkaloids, are the most commonly used in securing dilatation. In cases of unconsciousness in which the pupils are affected, be on the lookout for cerebral disorder such as apoplexy. If the pupils are of unequal size, it is very suggestive of brain disorder if the patient is unconscious. In other cases of eye disease, if the pupil does not respond to the stimulus of light but the focus remains normal, it is suggestive of spinal cord disease as in tabes dorsalis. This is called the Argyll-Robertson pupil.

A **milky** appearance of the pupil is indicative of cataract, which is characterized by opacity of the crystalline lens. Cataract has been classified in various ways by the different writers, the simplest being into soft, hard and secondary. The opacity may be in the capsule or the lens. It is essentially a disease of old age and is the result of mal-nutrition. Lesions of the upper cervical vertebræ will predispose to the formation of cataract as do diabetes mellitus, wasting fevers, over-work of the eyes, and irritative disorders of the eye, such as iritis, glaucoma, and diseases of the retina. The most frequent discoloration of the retina is white or milky, but it may be black or amber in color. A gentle tapping of the eyeball, is sometimes effective in restoring the sight by causing change of position of or absorption of the milk-like deposit.

If the **conjunctiva** is **jaundiced** it is suggestive of liver disorder. On account of the clearness of the normal conjunctiva, any bile pigment would easily be detected if deposited on it. A yellowish eyeball is indicative of ill health whether from liver or other disorder. A pearly

or bluish eyeball is suggestive of anemia or **chlorosis.** A retracted eyeball is present in wasting diseases but especially in acute disorders of the intestinal tract accompanied by diarrhea. It is particularly noticeable in cholera and in the summer diarrheas of children. In some cases the eyeball becomes shrunken while in others the retraction is due to the emaciation. A **prominent eyeball** is found in **exophthalmic goitre.** There is supposed to be formed a cushion of fat behind the eye which pushes it forward. This should not be confused with cases in which the eye is normally prominent. Landois says: "Protrusion of the eyeball takes place: (1) As a result of marked distension of blood-vessels, especially of the orbital veins, when there is an obstruction to the outflow of venous blood (for example in the head after execution by hanging). (2) As a result of contraction of the unstriated muscle fibers in Tenon's capsule, in the sphenomaxillary fissure, and in the eyelids, which are innervated by the cervical sympathetic." An irritative lesion in the neck would then produce exophthalmus. In the dog, section of the cervical sympathetic nerves will produce retraction of the eyeball or an inhibitor lesion will produce the same effect. The lesions in exophthalmic goitre are often found in the cervical region, thus both the effect on the eyeball and the thyroid gland can be accounted for. It has been observed that contraction of **Muller's muscle** produced protrusion of the eyeball. This muscle also receives its innervation from the cervical sympathetic and thus would be involved in neck lesions.

The **appearance of the eye** is indicative of the degree and character of the illness. In **pneumonia,** the eye is unusually **bright** and the patient is on the alert and sees everything that takes place in the room. In **typhoid fever,** the eye is **listless** and the patient is not cognizant of the surroundings. As a rule, the eye has a dull sleepy appearance and the movements of the eyelids are very slow in patients that are really sick. The eye of an **insane** person is **roving** and restless and the patient does not look his questioner in the face but attempts to avoid his eye. In alcoholism, the eye has a dazed expression; a similar one is seen in epileptics and confirmed masturbators.

Strabismus or squint, is indicative of weakness of the eye-muscles, of central disease and quite frequently of disorders of the cervical spinal cord as a result of a neck lesion. **Nystagmus** or rolling of the eyeballs occurs in hysteria, brain disorders and irritative conditions of the upper cervical cord. It occurs in convulsions and in the disease called Freid-

erick's ataxia. It is the direct result of a disturbance of the centers in the brain that control ocular movements.

A **blurring** of the **vision** is suggestive of disease of the optic nerve. If in the field of vision there appear floating objects, or if a part is obstructed, blindness will appear within a short while if care is not taken. If the object or "speck" is stationary that is, stays at such a point that the eye can not be focussed directly on it, it is probably due to a particle in the humor of the eye or else a congestion of some of the blood-vessels of the eye.

Hemianopsia, is the result of disease of the optic tract, that is in the optic nerve or chiasm, or of disease of the visual centers. In this disorder the patient often carries the head to one side in order that the rays of light may enter the eye to the best advantage. As pointed out before, disturbances of the cervical sympathetic nerves will affect the nutrition of the centers for vision and among other effects, hemianopsia sometimes results. **Diplopia** is usually binocular, and is the result of derangement of the muscular balance so that the image of the object is thrown upon two points of the retina instead of being focused on only one point. It most commonly is the result of strabismus but may occur in cases of impairment of vision and in constitutional diseases. Pressure on the eyeball will produce diplopia. The writer has seen some cases in which lesions of the upper thoracic and cervical vertebræ, were responsible for the disorder. It is not unusual for an injury to these regions to produce strabismus and double vision within a very short period of time. The explanation of the relation that exists between the eye and the cervical and dorsal regions lies in the fact that the motor, vaso-motor and secretory nerve supply to the eye comes almost entirely from the upper part of the spinal cord and muscular contractures and bony lesions in relation, will interfere with these nerves.

Pain in the eye is usually due to congestion of the eyeball. This congestion may be the result of eye-strain, brain disease, congestion of the centers for vision, reflexly from **disturbances of the pelvic organs** or from disturbances of the cervical sympathetic nerves through which vaso-motor and other impulses reach the eye. Pain in the eyeball often comes from increased intra-ocular tension as in glaucoma. Congestion of the brain will produce a similar effect. Intense **pain in one eye** may and often does come from pelvic congestion or inflammation; in the female a displaced uterus being frequently the cause. Abuse of the eye will produce a pathological congestion, hence the pain.

Weakness of the eyes has become a serious problem in the young. One has only to note the great number of people, especially young girls. that wear glasses. Weakness of the eyes may be a part of a general weakness of the body and should be associated, in the young, with weakness of the generative organs, and sexual abuses are responsible for many cases. The frequency of neck lesions is an important cause and often, in fact, in nearly all cases can the eyes be **at least strengthened** by the correction of the cervical lesions. By doing this, better circulation and nutrition of the eyes are assured and consequently they become stronger. In all eye affections whether the trouble is in the eyelids, lachrymal apparatus or the eyeball, examine for lesions of the articulations of the axis and the second thoracic vertebra. If the trouble is an inflammatory one, first of all carefully examine the eye for the presence of a foreign body that causes an irritation hence the congestion and inflammation.

THE EAR.

The **ear** is divided into the external, middle and internal ear. The external, includes the pinna and the external auditory canal. The **pinna** varies in shape and size in different individuals but these variations as a rule are of no practical importance except in the degenerate and the insane. The **color** of the **pinna** is indicative of the patient's state of health. If it is pale and anemic, the blood is impoverished and the patient is weak and anemic. If they are red or pink in color, it is indicative of good blood, hence a healthy condition.

The **external auditory canal** extends from the concha inward to the tympanum. From without in, it is directed upward, forward, inward and slightly downward. On account of these changes in direction, the pinna should be grasped and drawn upward and forward in attempts to inspect the canal. The canal is composed partly of bone and partly of cartilage, the cartilage lining the outer portion. The skin that covers the pinna is continued into the meatus and lines the entire cavity and covers the outer surface of the tympanum. That part lining the external portion has in it a number of tubular glands called the **ceruminous glands.** The **cerumen** serves as a lubricant and protects against the invasion of the part by foreign bodies. In the very rugged, there are several large, stiff hairs that guard the entrance to the canal. The canal serves as a conductor of the sound-waves to the tympanum. It

receives its **blood** from the posterior auricular, the superficial temporal and the deep auricular branch of the internal maxillary. Its **nerve** supply is principally sensory and is derived from the auriculo-temporal branch of the fifth and the auricular branch of the pneumogastric. These nerves are affected by neck lesions, subluxation of the lower jaw and by caries of the teeth. Contracture of the neck muscles as in the catching of cold, often brings on **earache** especially in the young. Such a lesion either affects the vaso-motor supply to the canal or else the sensory nerves direct. In the average case the disorder is due to a vascular change in which the blood pressure is increased, such being characterized by the throbbing pain. Earache from other causes consists of a continual, constant pain.

Although the **canal** is **curved** in several ways in order to prevent foreign bodies from getting into the canal, yet in children it is not unusual for cherry-stones, beads and other objects to find their way into the meatus. Insects sometimes pass into the canal and give rise to a great deal of discomfort in addition to the impairment of the sense of hearing. Soon after the entrance of the insect into the ear, that is, before it dies, it can usually be removed by pouring into the ear some luke-warm water.

Polypi occasionally form in the canal. They cause disturbances of the tympanum from pressure and in some cases seen by the writer, produced Bell's paralysis. A discharge of pus from the meatus, is indicative of suppuration of the mastoid process or of the middle ear, and perforation of the ear-drum. The ear should be thoroughly cleansed to prevent desiccation of the discharge on the tympanum.

The **escape of cerumen** occurs in anemic and constitutionally diseased children. Hardening of the ear-wax produces an impairment of hearing in that it interferes with the vibrations of the ear-drum. In all cases of **unilateral deafness** it is advisable to examine quite thoroughly the external auditory meatus; in tinnitus aurium, a desiccation of the wax may be the cause.

The **tympanum** is of importance from a pathological standpoint in that it is quite frequently the seat of disease. It is an irregularly shaped cavity in the temporal bone and connects the external and middle parts of the ear. It communicates with the mastoid cells and the pharynx. On account of these communications, disease may travel from the mastoid cells and the throat to the middle ear. The **ear-drum**

which separates the tympanum from the external ear, is a membranous structure that is placed obliquely in the canal. It is disc-shaped with its convexity directly outward. Its function is to transmit the sound waves to the middle ear and the ossicles. It does this by vibrating. If it is very tense, the vibrations are increased in intensity and roaring of the ear is the result. If it is relaxed, the sound-waves are not transmitted in a normal way and deafness, partial or complete is the result. If the **air-pressure is not alike on the two sides** of the membrane, it will be forced to the **side of lesser pressure** and its **function is affected thereby.** The membrane can be seen by the aid of an ear speculum. If it is healthy, it is of a "pearly-gray" color and presents a glistening surface. The short process of the malleus, appears as a whitish point while the handle of this bone forms a ridge leading from this point downward and backward.

The **tensor tympani** muscle produces by its contraction, increased tension in the tympanum by drawing the handle of the malleus inward. It is supplied by a branch from the motor division of the fifth, by way of the otic ganglion. Since lesions of the upper cervical vertebræ will affect the fifth nerve, such a lesion will affect the tone of the ear drum and thus an impairment of its function will result.

The tympanum receives its **blood** from the deep auricular branch of the internal maxillary, the tympanic branch of the same artery and from the stylo-mastoid branch of the posterior auricular. These arteries are supplied with vaso-motor impulses from the superior cervical sympathetics by way of the carotid plexus. Therefore a lesion that affects the source of these impulses or the nerves over which they are transmitted, will produce trophic and vascular disorders in the tympanum. It has been demonstrated clinically that such is the case.

The **veins** that drain the tympanum empty into the external jugular, the venous plexus that surrounds the Eustachian tube, the veins of the dura mater and partly into the lateral sinus. From this it is seen that muscular contractures of the cervical region, occlusion of the Eustachian tube, and congestion of the brain and meninges, will obstruct the drainage of the tympanum and thus produce vascular disturbances of it. Neck lesions are directly or indirectly responsible for vascular disorders of the ear-drum.

The **nerve** supply of the tympanum, comes principally from the auriculo-temporal branch of the fifth cranial, the auricular branch of the

pneumogastric, the tympanic branch of the glosso-pharyngeal (Jacobson's nerve) and the carotid plexus. Disturbances of these nerves affect the function of the ear-drum, therefore impairing the sense of hearing.

The **mastoid antrum** and **cells** are of interest in that abscesses occasionally form at these points. They may be affected from disease of the ear, trauma or by lesions of the neck in that the nerve supply to them is from the first cervical nerve.

The **Eustachian tube** connects the middle ear and the naso-pharynx. Its function is to conduct air to the tympanum in order that the pressure on the two sides of the ear-drum be equalized. The tube is composed partly of bone, internal part, and partly of cartilage. It is about one and one-half inches in length, is lined with mucous membrane that is continuous with that lining the naso-pharynx. In inflammation of the throat as in measles, the disease is prone to travel along the tube to the ear and there set up an otitis media. Catarrhal conditions of it are very common and lead to partial deafness and tinnitus aurium. The explanation is that in an occluded condition of the tube, the external air pressure forces in the tympanum, the internal pressure being lessened by the absence of air. In tonsillitis, sore throat, or in any disease of the throat characterized by congestion and swelling, the tube becomes partly or completely closed and partial deafness is the result. The fifth cranial nerve furnishes sensory impulses to the tube while the sympathetic or vaso-motor fibers, are derived from the cervical region by way of the superior cervical ganglion and the branches that accompany the internal maxillary and ascending pharyngeal arteries. The tube can often be opened by relaxing the contractured tissues of the throat and by relieving the congestion partly by deep, and forward and downward manipulation under the angle of the jaw, and by the correction of the cervical lesions that are so frequently present.

The **ossicles** of the ear are the **malleus, stapes** and **incus.** They form an irregular chain or line of levers through which the sound-waves are supposed to pass. They also furnish attachment for the muscles of the middle ear. Inflammatory diseases of the middle ear, such as otitis media, involve these bones and as a result, they poorly transmit the sound-waves and give insecure support to the muscles of the tympanum, the tensor tympani and the stapedius.

The **inner ear** consists of the **vestibule, semicircular canals, cochlea,** and the **membranous labyrinth.** This part of the ear is located in the

petrous portion of the temporal bone and is quite well protected against injury. Most of the disorders of this part of the ear, come from causes external to it, that is from extension of disease from the middle ear or from lesions of the upper cervical vertebræ that affect the nerve and blood supply of it. The **internal auditory branch** of the basilar with some minute branches from the stylo-mastoid, supply this part of the ear with blood. The **vaso-motor nerves** that accompany the internal auditory, are derived from the vertebral plexus which surrounds the basilar artery and gives off filaments with each branch. From this it can be seen that a lesion in the cervical or upper dorsal region will affect the ear in some way. Clinically, such lesions are found in cases of deafness due to derangement of the mechanism that receives the sound waves, and by correcting them, the symptoms are relieved. The explanation is that neck lesions affect, in this way, the nutrition of the inner ear or else the nutrition of the cells that form the auditory centers in the brain. This form of deafness is not so common as the form due to an impairment of the mechanism that conveys the sound waves, but is a great deal harder to cure than the latter form.

THE NOSE.

The **nose** which is the peripheral organ of smell, is divided into an external and an internal portion. The outer part is subject to trauma; fracture and depression of the cartilages being the most common of its affections. The condition of the nostrils is sometimes suggestive of a diseased condition of the respiratory tract. If markedly dilated during respiration, it is suggestive of obstructed respiration as in asthma. **Deflections** of the **nasal septum** are common and occasionally give rise to disturbances of respiration, the important one in children being, mouth breathing. Foreign bodies such as beans, buttons, etc., are often placed in the nostrils by children and should be thought of in cases of swelling of the nose accompanied by obstructed breathing. The nostrils are protected by stiff hairs in the adult, which lessen the amount of dust and other particles that would otherwise be drawn into the respiratory tract.

The **turbinated bones** are soft and usually affected in chronic catarrh of the nose. They may become thickened or absorbed and thus obstruct the passageway or give rise to a foul discharge as in œzena. They are also affected in chronic cases of hay-fever. The change in the character

in, and the accumulation of the secretions of the nose are principally responsible for the softening and decay of these turbinated bones. The disturbance of secretion comes primarily from cervical lesions that interfere with the blood supply and nutrition of the mucous membrane of the nasal cavity.

The **Schneiderian** or nasal mucous membrane lines the nasal fossa, contains many secreting glands, the olfactory cells and the terminations of the olfactory nerves. It is highly vascular, quite thick and firmly bound down to the adjacent bone and cartilage. It is continuous with the mucous membrane that lines the pharynx, conjunctiva and the various sinuses that communicate with the nasal fossa, and extends to the Eustachian tube, tympanum, the mastoid cells and anteriorly is continuous with the skin.

The **function** of this mucous membrane is that of **protection** to the delicate nerves that terminate in it, and the secreting of a mucus that moistens the terminals of the olfactory nerves and collects particles of dust that are drawn into the nose in respiration, thus preventing them from reaching the lungs. Since the principal diseases of this membrane and of the nose, are characterized by disturbances of secretion and since secretion depends so much on the amount and character of the blood circulating through the glands, it is important to understand the causes of vascular changes in them.

The principal **artery** that supplies the nasal mucous membrane is the **spheno-palatine** which is a branch of the internal maxillary. The branches of this artery supply the septum, antrum, frontal sinus, the turbinated bones and the meatuses. The **ethmoidal** branches of the ophthalmic supply the upper portion and outer wall of the nasal fossa. The facial also sends some branches to the nose. These arteries receive their nerve supply from the upper thoracic spinal cord by way of the superior cervical ganglion and its ascending branches that follow the carotid arteries. Lesions at the exit or along the course of these vasomotor nerves, will affect the transmission of the impulses and thus produce some effect in the parts supplied by them. These lesions consist of contractured muscles and bony subluxations. Usually the impulses are inhibited and as a result the blood-vessels dilate, in other words a congestion will result. In this there is the explanation of **nasal catarrh** and **hay-fever.**

The **veins** form into plexuses and empty into the ophthalmic, ptery-

goid plexus and the facial. In all likelihood they also have vaso-motor nerves that are derived from the same source as the arteries and would be affected in a way similar to the arteries. Communications are established between these veins and those of the cranial cavity by way of the cribiform foramina and the foramen cecum. On this account, nose bleed, will often relieve a congestion of the brain that is producing a headache. These veins also communicate with the facial, through the small foramina in the lower part of the nasal bones. Cunningham says: "The ethmoidal veins communicate with the ophthalmic veins and the veins of the dura mater; further, an ethmoidal vein passes up through the cribiform plate of the ethmoid, and either opens into the venous plexus of the olfactory bulb or directly into one of the veins of the orbital part of the frontal lobe of the brain."

The **sensory nerve** supply of the nasal mucous membrane is derived from the fifth cranial. The **nasal** branch of the ophthalmic, supplies the anterior and upper part. Branches from the **Vidian** and from **Meckels ganglion**, supply the outer wall, the roof, posterior part of the septum and the superior turbinated bone. The anterior or large palatine, supplies the lower part and the two lower turbinated bones. In addition to these, there are the **naso-palatine,** and **anterior dental** nerves. These branches of the fifth pair of cranial nerves are affected by neck lesions and by peripheral changes from the presence of foreign bodies or irritating particles in the nasal passageway.

The **olfactory** nerves pass through the foramina in the cribiform plate of the ethmoid bone and are distributed principally to the upper and posterior part of the nasal fossa.

The **sympathetic** nerve supply comes from the cervical region, the filaments following the arteries. Langley states that strong and moderately strong stimulation of the cervical sympathetic, produced intense flushing in the mucous membrane of the lips, gums, cheeks, hard palate, nose and in the neighboring parts of the skin. He further states that the vaso-motor fibers to the nose pass by way of the superior and inferior branch of the fifth. "Broadly speaking we may say that all parts of the skin and mucous membrane which receive their sole sensory supply from the fifth nerve, receive their sympathetic supply also by way of the fifth nerve."

Nasal catarrh is a vaso-motor disturbance of the mucous membrane of the nose caused primarily by lesions that affect the vaso-motor nerve

supply to it. Hay-fever is an exaggerated vascular disturbance of the membrane. This leaves the membrane in such an irritable condition that any exciting lesion will cause a marked stimulation that results in intense congestion followed by sneezing and increased secretion.

Nasal polypi are occasionally found in the nasal fossa. They, like growths on other mucous membranes, are the result of perverted nutrition. This interference with nutrition or circulation through the part may come from injury, as a blow on the nose, extension of disease from parts in relation, but especially from lesions of the cervical region that affect the vaso-motor nerve supply to the mucous membrane of the nasal tract. The indications of polypi in the nose are, mouth breathing, an anxious expression on the face, general malnutrition and deformities of the thorax if they occur in the young before the ribs have become as thoroughly formed as they are in the adult. A "stopping-up" of the nose is quite constant and the voice is muffled, that is, the patient is said to talk through the nose, but in reality the passing of the air through the nose in hindered or entirely obstructed, and the patient does not talk through the nose, hence the peculiarity of speech.

In recent colds and in chronic nasal catarrh, the nose is "stopped up" and the patient with difficulty can breath through the nose. Mouth breathing leads to throat disorders and enlargement of the tonsils. Adenoid growths in the nose produce similar effects on respiration, nutrition and the general condition of the individual. Any disorder of the nose may come from a cervical lesion whether it be a coryza or a polypus. The explanation, as given above, is that such a lesion will interfere with the vaso-motor innervation of the nose since the impulses on their way to the nose, pass in relation with the upper thoracic and cervical vertebræ. A tightening of the neck muscles will immediately produce a stopping up of the nose; sitting in a draught being the most common illustration.

THE MOUTH.

The **mouth** is affected directly by lesions of the neck that involve the fifth and seventh cranial nerves. In Bell's paralysis, the cheek is so affected that food accumulates between the teeth and the cheek on account of paralysis of the buccinator muscle. Lesions of the middle thoracic region affect the mouth by causing indigestion. An acid gas is produced which leads to accumulations in the mouth and on the teeth,

of particles of food and saliva that have undergone some change. In some cases the saliva is so changed that it produces canker sores in the mouth, the stomach in such cases being intensely acid.

The **gums** often show signs that are characteristic of certain diseases. In syphlitic children, the gums are usually red, thick and soft and the teeth soon become yellow, soften, crumble and drop out. The condition of the gums determines the condition of the teeth. They are richly supplied with blood-vessels from the internal maxillary artery. This artery receives its nerve supply from the spinal cord by way of the superior cervical ganglion and the carotid plexus. Since the condition of the teeth depends on that of the gums, and the condition of the gums on the internal maxillary artery, and the artery on the nerve supply to it, lesions of the neck that affect the nerve supply to the artery will affect the condition of the teeth. **Caries of the teeth** is on the increase, and it is partly due to the frequency of these **cervical lesions.** I believe that the teeth can be preserved by keeping the cervical region in an adjusted condition, in other words, the nutrition of the teeth is affected by these lesions. The teeth may be affected as a result of errors in diet, general nutritional disturbance, as in scrofula or tuberculosis in children in which the incisor teeth have a saw edge, and in syphilis, in which the teeth are notched, or the so-called Hutchinson teeth.

The appearance of the **tongue** is often indicative of the general condition of the patient, and its changes are of diagnostic importance in many disorders. It is composed chiefly of muscles and in addition to being the principal organ of taste, assists in speech, mastication and deglutition. The **mucous membrane** covering the tongue is continuous with that of the neighboring structures and contains the papillæ of the tongue. These **papillæ** give it the peculiar roughness that is so characteristic of the upper surface. The **muscles** of the tongue are divided into an extrinsic and an intrinsic group. The **extrinsic,** are the stylo-glossus, hyo-glossus, genio-hyo-glossus, palato-glossus and a part of the superior constrictor. These muscles control the movements of the tongue and are supplied almost entirely by the twelfth nerve. The pharyngeal plexus supplies the palato-glossus. Clinically, lesions of the neck affect this nerve, at least such lesions produce motor disorders of the tongue. The **intrinsic** muscles of the tongue form only a small part of it, being thin bands that are in close relation with the mucous membrane.

The **sensory** nerve supply of the tongue is derived from the lingual branch of the inferior maxillary division of the fifth; the lingual branch of the glosso-pharyngeal; some branches from the superior laryngeal; the lingual and chorda tympani, branches of the facial. The **motor** supply, is from the hypoglossus.

The chief **artery** of the tongue is the lingual from the external carotid. A few twigs from the facial and ascending cervical also reach the tongue. The principal vein is the **ranine.** On account of its close relation to the frenum, in operations for tongue-tie, it is sometimes cut. The **nerve supply** of the **vessels** of the tongue is derived from the upper part of the thoracic spinal cord and pass to the tongue by way of the branches of the superior cervical ganglion that supply the external carotid artery and its branches. Vascular and trophic disorders result from lesions that interfere with this nerve tract, they being found in the upper dorsal and cervical regions.

Enlargement of the tongue is indicative of inflammation or glossitis. A **livid, red** tongue is found in cirrhosis of the liver, and if round and pointed, is suggestive of acute intestinal disease such as dysentery. It is usually pale in anemia, especially so in chlorosis. A **coating** of the tongue occurs in nearly all disorders of the gastro-intestinal tract. Some believe that it is due to micro-organisms, others think it is due to precipitation of saliva. In typhoid fever, there is at first a yellowish accumulation on the back of the tongue, which is followed by redness of the tip and edges, and the formation of a deep median fissure. As the tongue becomes dried from the fever, other fissures develop and the color changes to a brownish one. In the ordinary gastro-intestinal diseases, there is a coating of a whitish or yellowish nature on the dorsal aspect. In children that drink milk, often the tongue has a white coating. In the "strawberry tongue," the fungiform papillæ which have been deprived of their epithelium, show prominently through the white coating. It is supposed to be quite indicative of scarlet fever, but occurs in many other diseases. A **dry condition** of the tongue is found in mouth breathers, in fevers and in cases in which the movements are lessened, this leading to a prolonged coating. Hare says "Dryness of the tongue in the presence of grave disease is always an evil omen, and returning moisture of the tongue a favorable one." He further says "Coating of the tongue aside from digestive derangements depends chiefly on three factors: first, immobility of the tongue so that it is not kept clean by

rubbing; second, mouth-breathing, whereby the surfaces become dry and less easily cleansed; and, third, fever, which not only dries the surface of the tongue by mouth-breathing, but interferes with salivary secretion.

The **movements** of the tongue depend on the integrity of the hypoglossal nerve. Lesions along the neck are sometimes responsible for impaired action of the tongue. In one case treated by the writer, a lesion of the axis produced intermittent spasms of the tongue. Diseases of the brain affect this nerve and hence impair the movements. In progressive bulbar paralysis or what is known as glosso-labio-pharyngeal paralysis, the tongue is progressively paralyzed so that speech, mastication and swallowing are difficult. In apoplexy and Bell's paralysis, the tongue can not be protruded in a straight line. The slow scanning speech which is characteristic of Freidreick's ataxia, is the result of the effect of the disease on the twefth nerve. Hare says "In still other cases pressure upon the nerve (the hypoglossal) in its foramen may cause unilateral paralysis, or wounds of the neck, caries of the first cervical vertebra, or cervical tumors may so result." This harmonizes with our observations along the line of disorders of the neck producing disturbances of the twelfth nerve. The **sensory** part of the fifth is also supposed to contain trophic filaments for the tongue and thus lesions of the cervical vertebræ that affect the fifth, may affect this part of it and produce atrophy and paralysis of the tongue. In **painful** affections of the tongue, the fifth cranial is the one involved. The pain may be a reflex one from disease of any other part of the nerve as in caries of the teeth, or it may be caused by lesions that affect the nutrition of the nerve or by structural disease of the substance of the tongue as in malignant growths.

If in the new-born, the tongue can not be protruded, a short frenum is usually present, it constituting the condition called, "tongue-tie." If the membrane is quite thin, it can be broken by means of the finger nail, but if thick, it will be necessary to sever the edge of the band with a pair of scissors after which, the frenum can be torn with the finger.

The **tonsils** are two oval shaped bodies located between the anterior and posterior pillars of the fauces. They are about an inch in length and one-half an inch in thickness and width. The mucous membrane covering them is continuous with that of the ôral cavity. The internal surface presents from ten to fifteen orifices that lead into recesses in

the surface of the tonsils, called **crypts.** The mucous secretion often fills these crypts. It forms a cheesy plug which undergoes decomposition and thus gives the breath a foul odor. Portions of these plugs drop into the throat especially in the morning, and are then expectorated It is associated with chronic nasal catarrh. Deaver says: "It is quite probable that germs in the stagnant secretion in the crypts of the tonsils, enter the lymphatic vessels, and cause many of the cases of inflammation and tuberculosis of the deep cervical chain of lymphatic glands." It is the rule for scrofulous children to have enlarged tonsils. The lymphatic glands of the neck and throat are in a state of chronic enlargement and the patient has a delicate and puny appearance.

The **blood supply** of the tonsil is derived from the ascending branch of the external carotid, the descending branch of the internal maxillary, the dorsalis linguæ branch from the lingual, the ascending palatine and tonsillar from the facial.

The **nerve** supply of these arteries is derived from the cervical sympathetic and the impulses pass to them by way of the carotid plexus.

In **vascular disturbances** of the tonsil, it is the rule for a **lesion** to be found in the **upper cervical region.** The explanation of this is that the vaso-motor impulses intended for the tonsil, are in some way obstructed by such lesions, since they pass in close relation with the upper thoracic and cervical vertebræ, and consequently the size of the blood-vessel is changed, it usually being increased. The **veins** of the tonsil empty into the tonsillar plexus which is drained by the pharyngeal veins. Contracture of the muscles and tissues in relation with these veins, obstruct the passing of the blood through them and a passive congestion of the tonsil follows. These contractures are the result of repeated colds but especially of cervical lesions. The **lymphatics** of the tonsil, which are quite numerous, empty into the lymphatic glands at the angle of the jaw and into the deep cervical glands. They are enlarged in disorders of the tonsils. They communicate with those draining the back of the tongue. The **nerves** supplying the tonsil are derived from the fifth cranial by way of Meckel's ganglion, and from the glossopharyngeal. The vaso-motor nerves accompany the arteries and in this way reach the tonsil and control its nutrition, and to a great extent its activity.

The **function** of the tonsil is not well understood but it is supposed to have an **internal secretion** that has to do with the elaboration of the

blood. Some recent investigators have stated that it was a useless organ like the appendix, and should be removed, as a prophylactic measure against tubercular infection of the lymphatic system. The writer is of the opinion that there is no superfluous part in the human body but that every structure has its special function and the tonsil is of this number.

Hypertrophy of the tonsil is often associated with pelvic disorders, that is, some forms of pelvic disease are complicated by its enlargement and inflammation. In mouth breathing, in talking through the nose, that is, if the voice is muffled, and in cases in which there is obstructed respiration accompanied by deformities of the thorax and a strained expression, it is well to examine carefully for enlargement of the tonsil. If the tonsil is enlarged to any great extent, it can be palpated externally, and the contour of the neck will be so changed that the diagnosis can be made from this external enlargement. The greater part of this enlargement below the angle of the jaw is, however, due more to the enlarged lymphatic glands than to the tonsil itself.

The principal **disorders** of the tonsils are, hypertrophy, inflammation and quinsy, which is a purulent form of tonsillitis. All of these diseases are the result of a disturbance of the circulation through the tonsils which acts as a predisposing cause and thus the exciting cause, the more easily and readily acts. By correcting the bony and muscular disturbances of the cervical region, the circulation through the tonsil can be so improved that it will assume its normal function and size provided the degenerative changes are not too marked. In some cases there is an obstruction below as in subluxations of the first rib and of the clavicle.

The **uvula** is a conical process that is suspended from the middle of the soft palate. It is of interest in that it often becomes elongated and irritates the sensory nerves in relation, thereby setting up a constant, hacking cough. This is especially true of out-of-door speakers. It derives its sensory innervation from the fifth, and its blood supply from palatine branches of the facial and the internal maxillary arteries. Lesions of the neck affect the blood supply to the palate, hence the uvula, and in this way produce congestion of it.

The **pillars** of the **fauces** extend downward from the uvula and embrace the tonsils. In sore throat, croup and diphtheria, these parts are the ones in which the disease starts. The vitality of these parts, like that of any part of the body, depends on the amount and character of

the blood circulating through them. If the blood-stream is slowed in the least, the quality of the blood is affected so that the parts are predisposed to the actions of the micro-organisms that might be in relation. If the vaso-motor nerves innervating the blood-vessels of the part are in a normal condition, the VIS A TERGO, that is the heart's action, will carry the blood on through, but if these nerves are inhibited, the circulation through the parts will be impaired. The impulses that supply the blood-vessels of the fauces, are derived from the upper thoracic spinal cord and pass by way of the sympathetic gangliated chain to the superior cervical ganglion, thence out over the carotid plexus and its branches that supply the branches of the carotid arteries. The point is this, lesions of the neck especially muscular contractures, interfere with the vaso-motor innervation of the soft palate and fauces and thus produce a congestion of the blood-vessels of the throat. Sitting in a draught of air will, in most people, produce soreness of the throat within a short time. Lesions of the cervical vertebræ will predispose to these muscular contractures and this explains the **difference in patients as to susceptibility to throat disorders.** In diphtheria, the blood becomes stagnated in the fauces and other parts of the throat, and the vitality is so lowered that the ever ready microbe finds a nidus favorable for propagation and this particular type of disease results. Contracture of the muscles of the front of the neck obstructs the venous drainage and thus makes the congestion the greater. Manipulation of these tissues coupled with correcting any disorder of the clavicles and first ribs, will relieve a case of sore throat within a very short time. The **mucous membrane** of the fauces is often the seat of an ulcer in secondary syphilis, called a mucous patch.

THE PHARYNX.

The **pharynx** is a musculo-membranous tube about four inches in length that is located behind the nasal cavities, larynx and mouth. It has opening into it the posterior nares, Eustachian tubes, mouth, esophagus and larynx. It carries the food from the mouth to the esophagus, "bridges the gap in the respiratory tract between the larynx and the nasal cavities," and gives resonance to the voice.

The **walls** of the pharynx are composed principally of the fibrous aponeurosis of the pharyngeal muscles, is lined with mucous membrane and surrounded by the constrictor muscles of the pharynx. Foreign

bodies that lodge in the pharynx are found in the lower end which is the smallest, at which place they obstruct respiration on account of relation to the larynx. In tetanus, the pharyngeal muscles are affected next in order to the muscles of mastication. The mucous membrane is continuous with that lining the cavities in relation. It varies in thickness and structure in the different parts. In the upper portion or what is called the **naso-pharynx,** it is provided with ciliated epithelium for the passing of air, while in the lower part or oro-pharynx, there is squamous epithelium. There are many mucous secreting glands throughout the pharynx which keep the throat moist and lubricated. Near the Eustachian tube there is an aggregation of these mucous glands and lymphatic follicles which constitute the so-called **pharyngeal tonsils.** Hypertrophy of these tonsils constitutes adenoid growths of the throat. They are found most frequently in the upper part, hence the disturbance of function would be, obstructed respiration and impaired resonance of the voice.

The **mucous** coat of the pharynx is very **vascular** and probably on this account, is pharyngitis or sore throat so common. The arterial supply is from the **ascending pharyngeal**; the facial by way of its **ascending palantine** and **tonsillar** branches; the **superior thyroid** through the **superior laryngeal** branch; and from the **inferior laryngeal** branch of the inferior thyroid. The size of these blood-vessels is determined by the condition of the vaso-motor nerves innervating them. They are derived from the upper thoracic spinal cord and, like the vaso-motor supply to other parts of the head and face, pass by way of the superior cervical ganglion and out over the plexus surrounding the carotid arteries, to their destination. The **veins** of the pharynx are arranged in a plexus that empties into the facial or the internal jugular. These veins are subject to impingement from contracture of the muscles of the front of the neck. The **lymphatics** empty into the cervical glands. The **nerve** supply of the pharynx in from the pharyngeal plexus. This plexus is formed by branches from the pneumogastric, glosso-pharyngeal nerves and by branches from the superior cervical ganglion. **Sensory** fibers are furnished it by the **pneumogastric** and to a certain extent by the **glosso-pharyngeal** nerves. **Motor** impulses are furnished it by the vagus, while the sympathetic branches from the superior cervical ganglion carry to it vaso-motor and secretory impulses. Since lesions of the cervical vertebræ, especially of the atlas and axis, affect any or all of the above

named nerves, almost any form of disease of the pharynx may result from an upper cervical lesion, because nearly all diseases have their origin in disorders of the innervation of the part diseased. The vaso-motor impulses that are supposed to be furnished the pharynx by the pneumogastric and glosso-pharyngeal nerves, come originally from the pharyngeal branches of the superior cervical ganglion. On this account, congestion and inflammation of the pharyngeal mucous membrane, hypertrophy of it as in adenoids, dysphagia from disorders of the constrictor muscles and sensory disturbances as in tickling in the throat which produces a chronic cough, may be the direct result of muscular and bony lesions of the upper cervical region. These lesions predispose to diseases of this part by weakening the natural resistance so that the exciting cause readily acts.

THE LARYNX.

The **larynx** is the organ of voice. It is composed principally of cartilages so arranged and united that they form a more or less rigid framework yet possessing a certain amount of movement which is necessary to the proper performance of the laryngeal functions. There are nine of these cartilages of which the thyroid and cricoid are the most important.

The **thyroid,** is the largest and consists of two alæ that unite anteriorly at an angle, thus forming the pomum Adami. This point is an important landmark of the neck. This cartilage gives attachment internally to the **true** and **false vocal cords.** It is attached to the hyoid bone by means of the thyro-hyoid membrane and the thyro-hyoid ligament. On account of these attachments, any displacement of the hyoid bone will usually affect the position of the thyroid cartilage and some disturbance of the voice will result. This cartilage is sometimes broken or displaced in injuries to the neck as in choking. It moves upward and downward in deglutition, it reaching the hyoid bone.

The **cricoid** cartilage is the strongest. It is situated below the thyroid and rests on the upper ring of the trachea. It can be palpated externally and forms one of the landmarks of the front of the neck. The remainder of the laryngeal cartilages are of such little importance from a practical point of view that they will not be considered here, except the **epiglottis.** This cartilage is a leaf-like door that guards the entrance to the larynx. During respiration,it lies in a vertical position but in swallow-

ing, it drops back and closes the superior aperture of the larynx. If one attempts to swallow and talk at the same time, the epiglottis is imperfectly closed and food is apt to enter the larynx. Nature tries to overcome the disturbance by setting up a violent fit of coughing in order to expel the foreign body. In the introduction of a stomach tube, the action of this cartilage must be considered.

The **muscles** of the larynx have been divided into the extrinsic and the intrinsic. These muscles have to do with the position of the various cartilages to which they are attached, hence determine the size of the lumen and the tone of the vocal cords. Disturbances of respiration, phonation and deglutition result from contracture or relaxation of some or all of them. They are innervated by the pneumogastric, through its superior and inferior laryngeal branches, and by branches of the cervical nerves that pass to the infra-hyoid muscles. The cervical nerves do not directly innervate the larynx but indirectly have to do with its position through the muscles that are attached to the hyoid bone. As a result of this, lesions of the neck produce disturbances of respiration and deglutition but especially of phonation, on account of effect on the nerves innervating both the intrinsic and extrinsic muscles of the larynx.

The **mucous membrane** of the larynx is quite vascular and is continuous with that covering the pharynx and trachea. Inflammation of it will spread by continuity of tissue, from one part to another and especially from above downward, as is often the case in diphtheria and bronchitis. Mucous glands are found in all parts of it except over the vocal cords. In congested and inflamed conditions of the laryngeal mucous membrane, the secretion of these glands is affected, sometimes increased, while in other cases it is lessened. In public speakers after long continued speaking especially in the open air, the throat becomes dry and the voice husky from lack of lubrication of the vocal cords. The **superior laryngeal nerve** supplies the part with **sensory** impulses and is quite often reflexly affected, as is indicated by the frequency of cough from disease of structure not in relation.

The **true vocal** cords consist of bands of fibro-elastic material, stretched between the anterior angles (vocal processes) of the arytenoid cartilages and the retiring angle of the thyroid cartilage on each side of the median line. In phonation they become tense and the passing of air through the chink between the true vocal cords sets up vibration of

them. The **false** vocal cords are folds of mucous membrane and have nothing to do with phonation. The tone of the vocal cords is controlled by the intrinsic muscles of the larynx. These are under the control of the pneumogastric nerve by way of its laryngeal branches. Contracture of these muscles or congestion of the true vocal cords, will affect the tone of the voice. Lesions of the upper cervical vertebræ, will not only affect the motor supply of the part, but the vaso-motor nerves supplying the larynx and the vocal cords.

The **blood supply** of the larynx is from the **superior** and **inferior thyroid** arteries. The superior, is a branch of the external carotid and through its superior laryngeal branch, supplies the greater part of the larynx. McClellan says: "Its radicles anastomose freely with those of its fellow and those from the inferior thyroid arteries, so that the mucous membrane is very vascular, as is demonstrated by the rapid engorgement and change from the ordinary pink color to a bright red in consequence of the slightest irritation." The inferior thyroid artery is a branch of the thyroid axis of the subclavian. The innervation of the superior thyroid is from the superior cervical ganglion, while the inferior, receives its nerve supply from the subclavian plexus. This plexus is derived from the inferior cervical and stellate ganglia. On this account, lesions of the lower cervical vertebræ but especially lesions of the upper two ribs, will affect the innervation of the arteries of the larynx, hence will produce disease of the part or at least a weakening with predisposition to disease. A tightening of the lower cervical muscles and of those attached to the first rib,is usually found is patients suffering with disorders of the larynx.

The **veins** accompany the arteries and empty into the superior, middle and inferior thyroid veins. Inward and backward subluxations of the clavicle, upward displacement of the first rib and contracture of the tissues of the lower part of the front of the neck, will obstruct these veins and tend to produce congestion of the larynx.

The **lymphatic** vessels accompany the veins and empty into the deep cervical glands.

The **sensory** nerve to the larynx is the **superior laryngeal,** a branch of the pneumogastric. The **recurrent** or inferior laryngeal is the **motor** nerve. The explanation of the course of this nerve has been the subject of much speculation for many years. Perhaps the best explanation is based on its function and action, it acting from below upward, or

rather in respiration and in coughing the muscles supplied by it act from below upward. The **sympathetic nerve** supply to the larynx, that is, the vaso-motor and secretory nerves to it, is derived from the cervical ganglia and pass to the larynx with the blood-vessels and the vagus. They are of importance in that they control the amount of blood and secretion of the part. In congestion, inflammation and in catarrhal conditions of the larynx, these nerves are affected.

Disturbance of function of the larynx results from conditions producing an irritability or narrowing of the cavity or openings of it. Inflammation of it which is called laryngitis, disturbs its function by lessening the size of the lumen, by thickening the vocal cords, weakening the muscles and by irritating the sensory nerves of the part. It is excited by many things, such as abuse of the part, but primarily produced by anatomical derangements by which the blood supply to, and the innervation of, it are affected, which so weaken the larynx that any exciting cause the more readily and easily acts. **Edema** of the larynx lessens the lumen and consequently respiration is embarrassed. **Laryngisimus stridulus** consists of a spasm of the laryngeal muscles which makes respiration difficult because of the narrowing of the larynx. This is often a reflex effect from gastro-intestinal irritation. In adults, it most frequently is the result of direct irritation of the motor nerve of the larynx from pressure as in goitre, aneurysms and in lesions that affect the nerve along its course or at its exit. The disturbances of **phonation** are the most important of effects of impairment of function of the larynx, because of their frequency and diagnostic importance. **Hoarseness** is the result of a thickening of the vocal cords from congestion. The congestion is the effect of muscular contracture from thermic influences and from subluxations of the cervical vertebræ. In some cases hoarseness is due to pressure on the vocal cords as a result of a tumor on, or in relation with, the larynx. If the voice has a nasal twang, it is indicative of obstruction of the air passages as in adenoids. In **stuttering**, the trouble is not necessarily in the larynx but is commonly the result of the individual attempting to speak with the lungs empty, hence the air is not directed in the proper way against the vocal cords and a sort of spasm of the laryngeal muscles is the result. If the patient were to take a deep inspiration before attempting to speak, this difficulty would be overcome and the muscles would not be thrown into a spasm. Since the party is able to sing or at least is able to produce a prolonged sound, it goes to prove that the fault

does not lie with the vocal apparatus but is in the mechanism that has to do with controlling the laryngeal muscles and the amount of air passing through the chink between the true vocal cords, called the **glottis vocalis.** In some cases the writer has found lesions of the neck and of the hyoid bone that had something to do in the production of stammering. A **slow,** hesitating, weak speech is indicative of marked weakness of the body as in the exhaustive fevers. A **jerky,** short speech is found in patients suffering with **pneumonia** and **pleurisy,** The explanation is that the air can not be expelled except spasmodically, on account of the pain from the pleurisy. In cardiac disorders, especially in marked palpitation, the speech is jerky and weak. A slow, scanning speech occurs in Friedreich's ataxia. In glosso-labio-pharyngeal paralysis, the speech is of a mumbling character and if the larynx is involved, there is great feebleness of the voice.

Aphonia is an effect of laryngeal disorder. Since phonation is dependent on muscular contraction by which the true vocal cords are made tense, anything that interferes with this will produce aphonia or at least impairment of the voice. In cases treated by the writer in which the trouble was not due to irritating gases, hysteria or trauma, a displacement of the hyoid bone was found in nearly all. The displacement is the result of contracture of some of the muscles attached to it, the **omo-hyoid** being most frequently affected. This contracture pulls the bone out of place and since the larynx is attached to the hyoid bone, it is affected. The displacment of the thyroid cartilage alters the tension of the vocal cords and consequently hoarseness or aphonia results. The cause of the contracture of the hyoid muscles is either a thermic one, or else there is a lesion of the upper cervical vertebræ that affects the innervation. In syphilis in which the mucous patches have formed in the throat, huskiness of the voice or even aphonia, is common. In other cases the vocal cords become thickened from inflammatory deposits and thus the vibratory qualities are impaired.

THYROID GLAND.

The **thyroid body** or gland is situated on the front and sides of the upper part of the trachea. It is a very vascular and belongs to the class of ductless glands. It consists of two **lobes** and an **isthmus.** Each lateral lobe is about two inches in length and about one inch thick and wide. The anterior surfaces are covered by the omo-hyoid, infra-hyoid,

sterno-hyoid, sterno-thyroid and partly by the sterno-mastoid muscles. Its posterior surface is adherent to the esophagus, and is in close relation to the larynx, pharynx, trachea, inferior thyroid artery and the inferior laryngeal nerve. The isthmus or middle lobe, connects the two lateral, and lies in anterior relation with the third ring of the trachea. It is firmly attached to the trachea and the thyroid and cricoid cartilages and on this account, it rises and falls with deglutition and can thus be differentiated when it is enlarged, from other enlargements of the neck. In the performing of tracheotomy, the incision should be made in the space immediately above the middle lobe and below the cricoid cartilage since this space is not covered by the gland. If the operation is performed below the gland there is danger of cutting the thyroid plexus of veins which is in relation. The gland varies in size in different individuals and in the same person at different periods. It is larger in women and children than in men. During menstruation it often enlarges quite considerably. In old age it decreases in size and becomes quite firm. In enlargements of the gland, the pressure symptoms are in evidence on account of the relation of the gland to the trachea and since the sterno-thyroid and omo-hyoid muscles prevent anterior displacement and thus it is forced backward against the structures in posterior relation.

The **arteries** of the thyroid gland are the **superior** and **inferior thyroid,** branches of the external carotid and the thyroid axis, respectively. The nerve supply of the superior, is from the carotid plexus which is a branch of the superior cervical ganglion. Lesions of the upper cervical vertebræ will affect the nerve supply to this artery and thus affect the thyroid gland. The **inferior thyroid** artery gets its innervation from the middle and inferior ganglia. The arteries are very large, anastomose freely and form a complete network around the acini of the gland. In some dissections made by the writer, these and the facial arteries were several times larger in cases of exophthalmic goitre than in the normal subject.

As a rule in this disorder, the arteries are considerably enlarged.

The **thyroid veins** are the superior, middle and inferior thyroid. The upper two empty into the internal jugular, while the inferior, anastomoses freely with the veins that drain the trachea, and empty into the innominate veins. Upward displacement of the first rib will indirectly exert pressure on these veins thus producing congestion of the gland. A downward and inward subluxation of the clavicle will have a similar

effect. In soft goitres, a treatment directed toward lowering the first rib and lifting the clavicle upward and forward, will temporarily reduce to a marked degree, the enlargement of the gland.

The **nerve** supply to the thyroid is derived from the superior,middle and lower cervical sympathetic ganglia, the branches reaching the gland along with the thyroid arteries. Gray states that the inferior laryngeal and possibly superior laryngeal nerves, send branches to the gland. Lesions along the lower part of the neck, upper thoracic region and of the upper ribs, will directly affect the innervation and tend to produce

Fig. 152.—Showing a very bad case of simple goitre. The patient has now begun to show indications of Cretinism. (From photo).

disease of the gland. The impulses that pass over the thyroid nerves are derived from the upper part of the thoracic spinal cord. They pass into the gangliated cord thence through the above named ganglia and out over the thyroid branches. Lesions of the upper ribs will especially affect the exit and origin of these nerve fibers and consequently are important ones in the production of thyroid diseases, such as goitre.

The function of the thyroid gland is not well understood at the present time. Experimentally it was ascertained by Horsley that **extirpa-**

tion of the thyroid gland in the monkey, was followed by **loss** of **appetite, fibrillary contractions** of muscles, **tremors** and **spasms, mucinoid degeneration** of the skin, giving rise to **puffiness** of the **eyelids** and **face** and to a **swollen** condition of the **abdomen,** hebetude of mind frequently terminating in idiocy, **fall** of **blood-pressure, dyspnea, albuminuria,** atrophy of the tissues followed by **death** of the animal in the course of from five to eight weeks. There seems to be an internal secretion that has to do with the elaboration of the blood. Brubaker says: "The view that the gland removes from the blood certain toxic bodies, rendering them innocuous and thus preserving the body from a species of auto-intoxication, is gradually yielding to the more probable view that the epithelium is engaged in the secretion of a specific material, which finds its way into the blood or lymph and in some unknown way influences favorably, tissue metabolism." Landois says that the morbid phenomena following extirpation of the gland, may be counteracted at least temporarily by the internal administration of thyroid gland substance. "These facts prove that the thyroid gland produces a substance that is indispensable for normal metabolism. Stated more accurately, the function of the thyroid gland is to neutralize a substance produced in the body, the accumulation of which, has a toxic influence on the nervous system."

The principal disturbances of function of this gland are **goitre** in which the gland is enlarged; **cretinism;** and **myxedema,** in which it is congenitally absent or else degenerated. There are many causes of these disorders but only the anatomical lesions that affect the gland will be discussed here. Clinically, in nearly all cases of exophthalmic goitre, there are found **muscular contractures** of the lower art of the cervical region and of the muscles attached to the first rib; subluxations of the **cervical** and **upper thoracic vertebræ; upward luxations** of the **upper two ribs** and a tightening of the tissues in relation with the first rib and clavicle. On account of the frequency of these abnormal conditions in goitre cases, and the fact that often by correcting the abnormalities the goitre disappears, we are warranted in stating that these disturbances affect the function of the thyroid gland. There are several reasons why the gland is affected by these lesions. (1) The tightening of the tissues interferes with the circulation to and from the gland by obstructing the blood-vessels, since they are in relation. (2) The displacement of the cervical and upper thoracic vertebræ causes contracture of the muscles

that are attached to the first rib, and it is drawn upward against the clavicle and thus obstructs not only the blood-vessels but the nerves that supply the gland. (3) These lesions directly affect the thyroid nerves and thus disturb their function, and as a result there are vascular and secretory disorders of the gland.

The first rib is usually displaced upward at its vertebral end and its sternal end is displaced backward and inward. This affects the inferior and stellate ganglia that are in relation with the head of this rib. The inward displacement of the sternal end produces pressure on the tissues and blood-vessels below the gland and thus interferes with the drainage. When these lesions are present, the exciting causes can the more easily act, such as pelvic disease, nervousness and the other exciting causes.

The **heart** is usually affected in exophthalmic goitre. The explanation given is that it is due to nervousness or to the toxemia that is present in the system, stimulating the heart. I believe the best explanation is that the same lesion that produces the goitre, produces the heart disorder by affecting the accelerator nerves to it. Lesions of the lower part of the neck, or of the upper thoracic region or upper ribs, affect the segments of the cord that give rise to the cardiac accelerators or else affect the pathway of these impulses, and since the nerves to the thyroid gland come from the same source and pass over practically the same route, that those that supply the heart do, that is by way of the lower ganglia of the sympathetic, both sets of nerves would be affected by the above named lesions.

THE TRACHEA.

The **trachea** in continuous with the lower portion of the larynx. It is about four and one-half inches in length, is about an inch wide and composed of cartilaginous rings that prevent collapse of it. These rings are absent posteriorly, thus giving the esophagus more room in deglutition. The trachea is of interest in that it is the seat of **inflammatory diseases; foreign bodies** occasionally lodge in it; and in that it is the structure incised in the operation of tracheotomy, for **obstructed respiration.** In croup and the laryngeal types of diphtheria, the membranes often get as low in the respiratory tract as the trachea and soon the child dies from asphyxia. Intubation is now generally substituted for tracheotomy whenever it is possible. The trachea is impinged on in aneurysms of the arch of the aorta, and in enlargements of the thyroid gland.

THE BRONCHI.

At the level of the body of the fourth cervical vertebra posteriorly and opposite the second intercostal space anteriorly, the trachea divides into a left and right bronchus. The bronchi vary in size, length and direction.

The bronchi subdivide at the roots of the lungs into the bronchial tubes. The tubes continue to divide until they become quite small, in which case they are called **bronchioles.** The bronchioles have no communication with each other, thus when one gets stopped, the corresponding vesicle is deprived of air and the resonance of the part is lost or lessened. The amount of cartilage decreases while the elastic and muscular fibers increase in proportion, as the tubes become smaller from division. **Mucous glands** are not found in the smallest branches but the larger tubes are abundantly supplied with them. The smallest bronchi have in their walls **unstriated muscle fibers** which have to do with controlling the size of the tube.

The bronchial tubes are lined with a **mucous membrane** which is of interest in that it is so frequently affected by extension of inflammation from above downward, and sometimes from below upward. Labored respiration, as in prolonged and vigorous exercise, will cause an increase of mucus secreted by these glands, lining the bronchial tubes and their ramifications. It has been noted by the writer that it is not only increased in amount but becomes quite tenaceous in character. In **asthma,** there is labored respiration and there is an increase in amount, and change of quality of the mucous from the tubes. This partly explains the formation of the spirals peculiar to asthma. Lesions affecting the mucous membrane, will produce a similar effect on the secretion of mucus as has been demonstrated in many clinical cases of bronchitis.

The **blood-supply** of the bronchial tubes is derived from the **bronchial arteries,** branches of the thoracic aorta. They are generally three in number, one on the right and two on the left side. These arteries supply the substance of the lungs, pleura, the bronchial glands, mucous membrane and walls, and the walls of the blood-vessels, and a few branches pass to the esophagus. The **nerve** supply of these arteries is, so far as can be determined clinically, derived from the thoracic aortic plexus. This plexus is formed by branches from the upper thoracic sympathetic ganglia, the impulses coming originally from the upper thoracic seg-

ments of the spinal cord. Muscular contractures in the upper dorsal region will, in most cases, produce some form of bronchitis, that is, congestion of the blood-vessels that supply the bronchial mucous membrane. Lesions of the first, second and third **thoracic vertebræ** and corresponding ribs, predispose to colds on the lungs or bronchial tubes, by affecting the vaso-motor supply to the parts, which reaches the tubes by way of the bronchial arteries. The blood returns to the heart by way of the bronchial veins, the right one emptying into the vena azygos major and the left, into the left superior intercostal vein. Since the superior intercostal veins drain the muscles of the upper thoracic region, contracture of the muscles of this part interferes with the drainage of the lungs, thus predisposing to congestion. In all probability, these veins have vaso-motor nerves which are derived from the same source as those that supply the arteries.

The **nerve supply** of the bronchial tubes is derived from the pneumogastric and the pulmonary plexuses. The vagus seems to be the motor nerve, while the sympathetic nerves supply the tubes with vaso-motor and secretory impulses. Landois says: "It appears that the function of the unstriated muscle-fibers in the trachea and in the entire bronchial tree, is to offer resistance within the air passages to the increased pressure that occurs in all forced expirations, as in speaking, singing, blowing, straining." Stimulation of the vagus is followed by contraction of these unstriated muscle fibers, thus interfering with expiration, by lessening the size of the lumen of the tube.

The **lymphatic** glands of the bronchi are situated at the bifurcation of the bronchi. They drain in part the visceral layer of the pleura, pericardium, back part of the heart, trachea and lungs. In early life they are pink in color, but as the patient advances in age they become pigmented from the deposit in them of particles of dirt.

The **function** of the **bronchial tubes** is affected by congestion and inflammation of the mucous membrane, and by constriction from contraction of the unstriated muscle fibers that are in the walls of the tubes. There are several causes of disease of the mucous membrane and constriction of the tubes other than lesions of the spine and muscular contractures, but only the connection that these lesions bear to the function of the tubes will be considered here.

Lesions of the **upper ribs** and **thoracic vertebræ** will affect the vaso-motor innervation of the tubes, because the impulses pass out of the

upper thoracic intervertebral foramina and in relation with the heads of the upper ribs and thus would be subject to pressure from a subluxation of either vertebra or rib. **Muscular contracture** in this region, interferes with the circulation through the upper thoracic spinal segments and thus affects the cells from which the vaso-motor impulses arise that supply the tubes. Asthma seems to be the result of stimulation of the motor nerves innervating the unstriated muscles surrounding the tubes, that is, branches of the pneumogastric. It may also be the result of congestion of the mucous membrane lining the tubes which produces a narrowing of the lumen and thus obstructs the passing of air through it. In some cadavers dissected by the writer, it was found that the vagus received branches from the upper thoracic sympathetic gangliated cord, the nerve filaments passing directly across from the ganglia into the sheath and substance of the pneumogastric. If this were true in all cases, the explanation of why lesions of the upper thoracic vertebræ and ribs produced asthma, would be comparatively easy. It has been demonstrated beyond a doubt that in most cases of asthma, a lesion in the above region was the cause of the trouble since by correcting the subluxation, the disease was cured unless emphysema had developed. It is recognized that there are exciting causes that have something to do in the production of the disorder but back of all these, the bony lesion is present in most cases. There are several reasons why such lesions produce asthma. They may directly irritate the motor nerves supplying the bronchial muscles; congest the mucous membrane lining the tubes; irritate the sensory nerves that supply the mucous membrane and thus excite reflex contraction of the tubes; or the lesions may increase the secretion of mucus, thus obstructing the lumen. It is the opinion of the writer that the **lesion most frequently affects the vaso-motor nerves supplying the mucous membrane** lining the bronchial tubes in such a way that it is congested and thickened, which not only causes a **narrowing of the lumen** of the tube from increase in thickness of the mucous membrane, but causes a **reflex contraction** of **the muscle fibers** forming a part of the wall of the tube.

THE LUNGS.

The **lungs** are the special organs of respiration and occupy, in the normal state, a greater part of the thoracic cavity. Each lung is composed of bronchial tubes, alveoli or air vesicles, blood-vessels, lymphatics

and nerves imbedded in elastic and fibrous tissues. The elastic tissue performs an important part in respiration, the distensibility and size of the alveoli being under the control of it so that when the lung tissue becomes diseased as in pulmonary tuberculosis, the elasticity is lessened or lost and the lung collapses. The two lungs differ slightly as to their lobes and form. The **right** is the larger, shorter, and possesses three lobes instead of two, as does the left. Each presents an outer and inner surface, anterior and posterior border, a base and apex. The outer surface is convex and corresponds to the concavity formed by the chest wall. This surface is in close relation with the upper ribs so that it bears the impressions of the ribs. The inner surface is concave and is in relation with the heart and the mediastinum. The contour and size of the heart determines to a great extent, the shape of this surface. The anterior border is quite thin and the two almost touch in the median line in deep inspiration. The **left** is deeply notched, thus leaving the pericardium uncovered. The posterior border is in relation with the bodies of the upper thoracic vertebræ, and is quite thick. On account of this relation to the vertebræ, the size and condition of the lungs have a great deal to do with the **contour** of the **thoracic part of the spinal column.** The base of the lung is concave to conform to the convex surface of the diaphragm with which it is in relation. The **apex** is rather blunt and rounded, and rises above the level of the first costal arch. In deep inspiration, the apex therefore passes upward through the inlet of the thorax and thus the contour of the parts in relation with the clavicle and first rib, depends on the **height** and **degree** of **development** of the **apices of the lungs.** This is of interest in that a **deep infraclavicular** or **supraclavicular fossa,** is suggestive of **weakness,** if not disease of this part of the **lung.** This part of the lung is the least used in ordinary respiration, and probably on this account, is most subject to diseases that attack the substance of the lung as in pulmonary tuberculosis.

The left lung is divided into two lobes by a long, deep fissure, while the right has two fissures that divide it into three lobes. These fissures and lobes are subject to great variations and are of little practical importance. The lungs are surrounded by a double fold of serous membrane called the **pleuræ.** Each pleura forms a closed sac in which is a fluid that serves to lubricate the two surfaces. It is the rule to find on post-mortem examination, **adhesions** uniting the two pleural surfaces; the result of pleuritis.

The **relations** of the **lungs** are important, in that disease of them is often due to impairment of some contiguous structure. The bodies of the upper thoracic **vertebræ** are in relation posteriorly. Lesions of them, such as an anterior subluxation, or disease as in caries or Pott's disease, will directly affect the lungs on account of the contiguity. In respiration these vertebræ are moved; posteriorly in inspiration and anteriorly in expiration. In lesions of the vertebræ whether it be a distinct subluxation or simply a stiffened or anchylosed condition, this movement is impaired.

The **ribs** are in posterior and lateral relation with the lungs. The contour of the chest is dependent on the size of the lungs. A displacement inward of any of the ribs in relation will cause direct pressure on the lung substance and thus lead to disease of the lung. The expansion of the lungs is restricted by certain rib lesions and soon the contour of the chest changes.

The **heart** lies between the two lungs and bears an intimate relation to them. Diseases of the one will necessarily affect the other, this being especially demonstrated in pneumonia in which the heart symptoms have to be combated more than any other in order to prevent a serious termination. This, however, is not the result of contiguity. In enlargement of the heart, the lungs are compressed and respiration is considerably embarrassed. In a dissection made recently, there was a marked pericardial effusion that displaced the lungs backward and laterally to such an extent, that the contour of the chest was changed. In such cases, the lungs are so compressed that the circulation through them is affected and consequently pneumonia and other lung diseases develop from the least exposure or other exciting cause. On the other hand, enlargement of the lungs, affects the heart by compression and thus produces irregularities or other disturbances of the heart-beat.

The **diaphragm** is in inferior relation with the lungs, the concave surface of the lung fitting accurately on the convex upper surface of the diaphragm. In descent of the diaphragm the lung follows, while a diseased lung pressing directly on the diaphragm, will often produce coughing and respiratory disorders. The **stomach** is in inferior relation with the left lung, the diaphragm separating the two. Distension of the stomach causes shortness of breath, as is demonstrated by exercise after a full meal. In accumulation of gas in the stomach, respiration is affected as well as the action of the heart. The **liver** is in inferior relation

with the right lung and, as in the case of the stomach, the diaphragm intervenes. In abscess of the liver, the lungs may be involved, pleural adhesions being the most common effect. Liver disturbances may cause a cough from irritation of the phrenic or perhaps from effect of the pressure on the lungs. On account of this relation, diseases of the lung, especially the pleura, are mistaken for liver affections and vice versa. The **venæ azygi** veins are in close posterior relation and are **subject** to **pressure** in all cases of **enlargement** of the **lungs** and in **patients that are forced to lie, for any length of time, on the back.** The **veins** of the **left side cross** to the vena azygos major and are especially subject to pressure from the above named causes since they rest on the **bodies** of the **vertebræ,** and thus are the more easily compressed. Lying on the back for several weeks, as in typhoid fever, is an important factor in producing congestion of the structures and parts drained by the azygi veins. These veins drain the spinal cord in particular and also the muscles of the back. Many a case of paralysis results from permitting the patient to lie on the back too long at a time, especially if the patient is old and feeble or if very much exhausted from a long, debilitating illness. The explanation is that the lungs press on the azygi veins and consequently there is a passive congestion of the spinal cord sufficiently great to interfere with its functions.

The **nerves** in posterior relation with the lungs, principally the sympathetic gangliated cord and its branches, are likewise subject to pressure from congestion or other enlargement of the lungs. This is also true of the thoracic aorta and the inferior vena cava, but ordinarily these structures are free from pressure unless the enlargement is quite marked.

The **pleuræ** closely invest the lungs. There is really no pleural cavity since the parietal and visceral layers are in contact in all normal cases. In pneumothorax and hydrothorax, these layers are separated so that there is a cavity formed between them. The **parietal** layer lines the thoracic cavity and is affected in fractures and dislocations of the ribs. On account of the proximity of the two layers, inflammation of the one will directly affect the part of the other layer in relation. Therefore **lesions** or **fractures** of ribs, **will affect the visceral** as well as the **parietal layer** and thus may produce disease of the lungs. The innervation of the parietal layer is derived from the intercostal nerves in relation and the pain in lung disorders is usually referred to the chest wall on this account.

The pleuræ permit of **free** and **easy movement** of the **lungs** and to a certain extent, protect them against injury. Distension of the lungs as in inspiration causes the two surfaces of the pleuræ to glide on each other, they being lubricated by a slight amount of fluid. The **pleura protects** the lungs against further injury by **limiting** the amount of motion in respiration, if the lung is diseased as in pneumonia. It does this by producing pain whenever the parts are moved which acts as a warning to the organism that the parts need rest. Most, if not all, of the **sensory nerves** that have to do with the lungs, **are in the pleura** and whenever the lungs move, these nerves are irritated and pain is the result. If this were not the case, it would take quite a long time to secure healing of an injury or diseased condition of the lungs.

The **condition** as well as the **position** of the lungs, is determined by **percussion** and **auscultation.** The normal lung gives a resonant, elastic note on percussion. In order to get best results in percussion, the patient should be in the sitting or erect posture and the fingers placed parallel with the ribs. The precordial dullness, the tympanitic note of the stomach and the marked hepatic dullness, serve as a contrast to the resonant note of the lung.

The **surface markings** have been considered. (See Thorax as a Region). The **apex** of the lung extends slightly above the first rib, while the lower border extends as low as the sixth rib in the mammary line, the eighth, in the axillary and the tenth rib posteriorly. In deep inspiration the lung descends about the width of a rib lower in the thoracic cavity.

The **blood** passing to the lungs comes from two distinct sources, the **bronchial** arteries and the **pulmonary** veins. The bronchial, are derived from the thoracic aorta and serve to carry nutrition to the substance of the lung. These arteries follow the bronchi and give branches to them, the "lymphatic glands at the hilus of the lungs, the large trunks of the pulmonary vessels (vasa vasorum), and the pulmonary pleura." There is some anastomosis between the two sets of blood-vessels. The bronchial arteries receive their vaso-motor impulses from the upper thoracic segments, they passing by way of the pulmonary and aortic plexuses to the arteries. The pulmonary vessels send out many branches that "follow those of the air-passages, and are so closely applied to the latter that their pulsations may be communicated to the contained air." These vessels also receive their nerve supply from the upper thoracic

segments of the spinal cord, they passing by way of the pulmonary plexus. The **bronchial veins** drain the substance of the lungs. They empty into the vena azygos major on the right, and into the left superior intercostal on the left. On this account they are subject to pressure or other disturbances from contracture of the muscles of the back and from enlargement of the lung. Landois says: "Part of the vessels arising from the capillaries communicate with the beginnings of the pulmonary veins; and for this reason any considerable stagnation of blood in the lesser circulation causes a like stagnation in the circulation in the bronchial mucous membrane, with resulting bronchial catarrh." This is of value in explaining the various effects of pulmonary congestion, as well as the results of upper thoracic lesions. Experimentally, it is hard to estimate the blood-pressure and speed of the current of the flow, since the chest has to be opened and this destroys the mechanism of respiration. The walls of the pulmonary vessels are considerably thinner than those of other vessels of the same caliber. This is indicative of a lessened blood-pressure. Howell's Text-Book of Physiology says: "As the pulmonary artery and veins lie wholly within the chest, but outside the lungs, their trunks and larger branches all tend to be dilated continuously by the elastic pull of the lungs—a pull which increases at each inspiration. On the other hand, the pulmonary capillaries lie so close to the surface of each lung that they are exposed to the same pressure, practically, as that surface, and the full weight of the atmosphere may act on them. These conditions all tend to unload the capillaries and the pulmonary veins, but to weaken the unloading of the pulmonary artery."

In congestion of the lungs as in lobar pneumonia, the danger lies in the weakening of the right heart which has to do with the lesser circulation. The vaso-motor nerves to the pulmonary blood-vessels are derived from the upper thoracic spinal segments, principally the second and third, and pass to the lungs by way of the pulmonary plexuses. Lesions of the upper five thoracic vertebræ either affect the origin of these vaso-motor nerves to the lungs or else they interfere with the connection, or line of communication, existing between these nerve cells and the lungs. Contracture of the upper thoracic muscles has a similar effect and these lesions are present in all cases of lung disorder. The usual effect on the vaso-motor nerve is that of inhibition, judging from the effect on the size of the vessels innervated. Diseases are predisposed to, since the vessels are engorged, the speed lessened and the vital-

ity of the part lowered, which conditions make it possible for the micro-organisms to become active. These nerves from the upper thoracic segments, also contain **trophic** and **secretory** fibers. The pneumogastric contains trophic, sensory, secretory and afferent pressor fibers. Undoubtedly the vagus is controlled or at least influenced by the upper thoracic nerves, for clinically, lesions in this region disturb the function of the pulmonary branches of this nerve. Perhaps all of the nerves that have to do with supplying the lungs, are connected with the respiratory centers in the medulla, and in this way the pneumogastric would be indirectly affected by the upper thoracic lesions through the effect on the medulla.

There are many **lymphatic vessels** of the lungs and they empty into the bronchial glands. The color of the lung varies with the age of the individual. During infancy it is a distinctly pink color and gradually becomes darker as particles of coal dust and other matter, are deposited in them until the lung becomes slate color.

The function of the lung is to **furnish oxygen to the blood** which is indispensable to the organism. The **quality of the blood** depends more on the **amount of oxygen** in it, than upon all ather things combined. The patient becomes fatigued in proportion to the amount of toxic matter in the blood. Since oxygen destroys the toxic materials in the blood, after all, fatigue can be measured by the amount of oxygen that is available for the use of the organism. In order that this function of purifying the blood be exercised to the best advantage, the pulmonary circulation must be normal, the nutrition of the lung be in good condition, that is, the bronchial vessels be normal, and the air passages be open. Lung diseases depend on impairment of one or more of these conditions. An impairment of the pulmonary circulation results from cardiac weakness, structural disease of the lung, and lesions of the upper thoracic vertebræ and ribs that affect the vaso-motor innervation of these vessels. **Pneumonia** is a good representative of this type of disease. Shallow breathing from laziness or other cause, is responsible for many cases of impaired pulmonary circulation. The nutrition of the lung is under the control of bronchial vessels and they in turn, under the nerve centers in the upper thoracic spinal cord. Therefore, lesions in this region impair the nutrition of the lung. Another important point concerned in the nutrition of the lung is **use.** Any part of the body tends to undergo atrophy and degeneration if not used, and the

lung is no exception. The using of the part is indispensable to normal circulation of blood through it. **Pulmonary tuberculosis** is the best type of structural disease of the lung. It attacks the parts least used, that is, the parts of lowest vitality, viz., the **apex.** In **broncho-pneumonia,** the function of the lung is affected in several ways: from obstruction to the air-passages from thickening of the mucous membrane, and from congestion of the bronchial vessels. In **asthma,** the air-passages are obstructed and thus the function is affected. On account of the fact that the arteries of the lung belong to the class called end arteries, emboli lodging in the lung, cause much disturbance of function since the circulation of the part beyond the point of obstruction is practically cut off, from lack of anastomosis.

The **effects** of disturbances of function of the lung are characterized by quickened, shallow respiration, getting out of breath readily, and impoverished blood that may give rise to almost any symptom. The **contour** of the **chest** is altered in accordance with the change in size of the lung. The **lesions** that are **primarily responsible** for these disturbances of function are: subluxation of one or more of the upper four ribs and vertebræ, prolonged or repeated contracture of the upper thoracic muscles and lesions of other parts of the body that interfere with elimination of toxic material so that the blood is impoverished and consequently the lung is over-worked. The upper thoracic lesions affect the lungs by direct pressure on them, pressure on the veins draining them and by affecting the origin and course of the nerves that supply, they coming from the upper thoracic spinal cord. If the spine in this region is flat or straight and the ribs oblique, the patient either already has lung disease or will have whenever the exciting cause, the micro-organism, becomes active.

THE HEART.

The **heart** is a hollow muscular organ that has to do with propelling the blood through the vessels of the body. It is pyramidal in shape with its apex directed downward and to the left in relation with the left nipple. The normal heart is about the size of the closed fist and has little or no fat in its makeup. The size varies with the amount of work required of it, it being large in those who exercise a great deal and in those suffering with some form of cardiac regurgitation, since it attempts to overcome the leakage by compensatory hypertrophy. The heart has four cham-

bers, the two auricles and the two ventricles. They are of interest in that they increase in size in certain forms of heart disease. The walls of the auricles are weaker than those of the ventricles and on this account they respond to external pressure, as in pericarditis with effusion, more readily than do the ventricles. The left ventricle is stronger than the right, since it has to do with the greater circulation, the right with the lesser or pulmonic circulation. The **muscle fibers** of the auricles are arranged in two layers, an outer and an inner. They surround the openings of the veins, being especially marked around the inferior vena cava. On account of the arrangement of the muscle fibers in this way, the auricle is able to contract independently of the ventricle. The **superior caval** opening, on account of the direction it faces, is not guarded by a valve while the other openings usually have valves to prevent regurgitation. The Eustachian valve is quite large in the fetus and serves to direct the blood across to the foramen ovale which leads to the left auricle. Sometimes this foramen does not completely close at birth and consequently the blood is not properly oxygenated and a condition called cyanosis neonatorum or "blue baby" results. The opening leading into the right ventricle, is guarded by the tricuspid valve, which like the other valves of the heart, is composed or formed from the endocardium. In disease of the endocardium or in obstruction of the pulmonary circulation as in pneumonia, this valve imperfectly guards the opening from weakness as in endocarditis or on account of increased pressure against it from the pulmonic obstruction. Incomplete closure in indicated by a murmur that is detected most readily by auscultation over the sternal end of the second rib on the right side. The **right ventricle** by its contraction, forces the blood around the lesser circulation. If this function is impaired in the least, the quality of the blood is impaired, since it is not properly purified. In obstructions to the course of the blood, the ventricle undergoes hypertrophy and thus compensation is established. The **valves** that guard the entrance into the pulmonary artery are called the semilunar valves. Occasionally these valves become thickened so that they close imperfectly or else the lumen is so much lessened in size that the normal amount of blood cannot pass through, both producing a murmur. The **left auricle** receives the blood after it is oxygenated and forces it on through the bicuspid valves into the left ventricle. The left ventricle has by far the thickest walls because the blood by the contraction of these walls has to be forced

around the greater circuit. Whenever there is any impairment of the systemic circulation, greater work is thrown on the left ventricle. Violent exercise increases the force of the ventricular contraction and in athletes, the left heart is usually enlarged. If the exercise is not kept up, fatty degeneration may set in and death result from any sudden over-exertion. In disease of the arteries as in **artero-sclerosis,** the left ventricle is affected on account of the increased work thrown on it in order to force the blood into a set of vessels that are less yielding than the normal, As the work required of the left ventricle is increased, the pressure within the ventricle increases and often the valves guarding the auriculo-ventricular opening give way and the blood is forced back into the right auricle. This is called **mitral regurgitation.** In addition to the increased work of the heart, the condition of the bicuspid valves should be considered, since if they are weakened from disease as in endocarditis, they give way on the slightest increase of the pressure in the ventricle. **Compensatory hypertrophy** is to be sought in such cases so that the increased force of the cardiac contraction, will make up for the blood regurgitated. In all cases of regurgitation, the heart with difficulty responds to emergency calls as in vigorous exercise and the patient gets "out of breath" and is readily fatigued. There is nothing that will so rapidly weaken an individual as some derangement of the heart, as in palpitation, since the purity of the blood depends on proper oxygenation, and this is impossible in such cases, and the strength of the patient depends on the purity of the blood.

The **pericardium** is a fibro-serous sac that encloses the heart and the roots of the great vessels. It is quite strong and tough and loosely surrounds the heart. It is attached above to the great vessels, each receiving a separate investment. Below it is firmly attached to the central tendon of the diaphragm, and anteriorly it is attached to the sternum by means of bands or ligaments. It has **two layers,** a **serous** and a **fibrous.** The **serous,** is smooth and glistening and is divided into a visceral and a parietal layer. These layers permit of free movement of the heart. A few drachms of a straw-colored fluid is found in the pericardium in the normal subject. In pericarditis with effusion, there may be a pint or more of the fluid. In a dissection made by the writer, the lungs were markedly displaced by an effusion that doubled the size of the space occupied by the pericardium.

The **arteries** supplying the pericardium, are derived from the internal

mammary, bronchial and the esophageal. The branches of these arteries are surrounded by nerves that control their size which are derived from the plexuses that surround the subclavian and the thoracic aorta.

The **nerves** are the phrenic, pneumogastric and sympathetic filaments from the plexuses in relation, the pulmonary and the aortic, they reaching the pericardium by way of the blood-vessels. In **effusions,** there seems to be a congestion and irritation of the pericardium that are responsible for the increased secretion. Lesions of the upper ribs were found in all cases seen by the writer. These lesions affect the pericardium through the nerves and blood-vessels supplying it; a congestion of the blood-vessels being the effect. The action of the heart is hampered, respiration disturbed, and the contour and percussion note of the chest in relation changed, if there is much effusion. "A rich net-work of lymph vessels lies within the pericardium itself, as well as more deeply toward the muscle-mass of the heart."

The **endocardium** lines the cavities of the heart and forms the valves. It is of special interest in that it is frequently diseased and consequently the action of the valves affected. **Endocarditis** is the usual form of disease and is supposed to be most frequently the result of articular rheumatism. Perhaps the toxemia that accompanies the rheumatic fever is partly responsible for the endocarditis but I am of the opinion that it alone is not a sufficient cause for the inflammation. In cases of rheumatic fever treated by the writer, cardiac complications were prevented by correcting all lesions that ordinarily affect the heart, such as subluxations of the upper ribs and vertebræ and contracture of the muscles of the back. By such a treatment, the circulation and nutrition of the heart was kept in good condition and the changed condition of the blood had apparently no effect on the endocardium. It is advisable to keep the patient quiet for a considerable length of time after the disease is supposed to be overcome, since in all cases the strength of the endocardium is lessened and any exertion may throw too much strain on the already weakened valves, and cause them to rupture or become thickened from congestion.

The **relations** of the **heart** are of importance in understanding the effects on the heart of other disorders, and the effects on adjacent organs from cardiac disease. The **apex,** is in relation with the central tendon and left leaflet of the diaphragm, to which the pericardium is attached. In descent of the diaphragm the heart, and through it the cervical fascia

to which the pericardium is attached above, are drawn down. McCellan states that he is not of the opinion that the central tendon descends with contraction of the diaphragm, but that only the leaflets descend. The **stomach** is in inferior relation with the heart. This is of importance in that distension of the stomach with food or gas, will embarrass the heart's action. The writer has treated many cases in which the patient declared that the trouble was one of cardiac disease, but stomach disorder, such as enlargement and distension, was found. On account of the intimate relation of the stomach and heart, **acid eructations** from the stomach are popularly called "heart burn." In some cases the **liver** when enlarged, reaches to, and is in relation with, the lower part of the heart. **Anteriorly,** a portion of it is not covered by the lung and it is in relation with the chest wall and sternum. **Displacement inward** of the **ribs in relation** with the heart, especially the **fourth rib** on the left side, causes pressure on the heart and embarrasses its action. In many cases of cardiac disturbance, the symptoms can be immediately relieved by adjusting these ribs, that is, by restoring them to their normal position. The lungs are in lateral relation with the heart, the heart and the great vessels separating the two lungs. **Posteriorly,** are found the descending aorta, esophagus, the lower right pulmonary vein, and the bodies of the fifth, sixth, seventh and eighth thoracic vertebræ.

In the process of development of the heart, it descends somewhat and thus the nerves to it are stretched and elongated as are the nerves of the ovary and testicle. As in the case of all viscera, the nerves and blood-vessels come from a point considerably higher in the spine than the level of the viscus. On this account, look for the lesion to be above the affected viscus rather than below it.

The **blood-supply** of the heart is derived from the coronary arteries, branches of the ascending aorta, which come off from a point called the sinus of Valsalva. These arteries, the right and left coronary, supply every part of the muscular substance, and the valves, if there are muscle fibers in them. *"Blood-vessels occur in the auriculo-ventricular valves in considerable numbers only where there are muscle-fibers." (Landois). The semilunar valves are supposed to contain blood-vessels only under pathological conditions. The endocardium, so far as it can be ascertained, has no blood-vessels in it. The **arteries** of the heart are essential-

*Text-book of Human Physiology, p. 92.

ly **end-arteries** since "the resistance in the narrow communicating branches is too great for an efficient circulation to be maintained through them. Thus, closure of any one of them is followed by sudden anemia and infarction of the capillary areas which they supply." (Langley).

The **nerve supply** of these arteries is derived from the vagus and the cardiac plexus, the vaso-dilator impulses passing over the pneumogastric and the vaso-constrictor impulses are carried by the sympathetic filaments that branch from the cardiac plexus. These vaso-constrictor impulses seem to come principally from the fourth thoracic spinal segment of the cord, since lesions in this region affect the blood-supply and nutrition of the heart. Calcification of the coronary arteries often occurs in the aged. The frequency of this condition is believed to be due at least in part to the great thickness of the elastic and connective tissue intima. **Angina pectoris** is attributed to faulty nutrition of the heart substance, possibly the result of an atheromatous condition of the blood-vessels of the heart.

The **veins** accompany the arteries and return the blood from the walls of the heart. They are divided into the great anterior and posterior cardiac veins, and the coronary sinus. The coronary sinus receives a greater part of the blood, the opening of which is guarded by a valve called the valve of Thebesius.

The **nerve supply** of the heart is derived from the **pneumogastric,** the **cervical sympathetic ganglia** and the **upper thoracic ganglia.** The immediate supply is from the **coronary plexuses** and the **intrinsic ganglia,** the ganglia of Remak and of Bidder.

The **vagus** supplies the heart through the external branch of the superior laryngeal nerve, inferior laryngeal nerve and sometimes through the pulmonary branches of the vagus. The vagus contains both afferent and efferent fibers. Some have stated that the efferent fibers leave the medulla by way of the spinal accessory, while more recent investigators claim that "they leave the medulla along the path by which the afferent fibers enter and never become associated with the spinal accessory nerve at its origin." The vagus is regarded by most investigators as the viscero-inhibitor nerve of the heart, that is stimulation of it, produces cardio-inhibition. Some claim that it also contains motor fibers and that stimulation of this nerve produces an acceleration

*Schafer's text-book of Physiology, Vol. II, p, 164.

of the heart-beat. The writer has seen a few cases in which marked effects could be obtained on the heart by manipulation of the pneumogastric nerve in the neck. Stimulation along the course of the nerve decreases the rate, while inhibition increases the heart beat. Practically, such treatments, are of little value since the only effect obtainable if any is gotten at all, is a temporary one and is not curative, since the cause of the disorder is not removed by such treatments. The entire theory of controlling the heart's action by treatment of the pneumogastric nerve is wrong unless it is primarily at fault, since only an effect is counteracted and that in an improper way. To properly regulate the action of the heart, control the amount of motor impulses that supply it, they passing to the heart by way of the sympathetic branches of the lower cervical and upper thoracic ganglia.

Physiologically and clinically, the superior and middle cervical ganglia have little or nothing to do with the nerve supply of the heart. Langley is of the opinion that the sympathetic impulses to the heart pass through the stellate ganglion and that none of them pass by way of the superior and possibly the middle cervical ganglia. Clinically, this seems to be the case, for it is the exception for lesions in the neck to have any direct effect on the action of the heart.

The **cardiac accelerator** nerves arise in the upper thoracic segments of the spinal cord and the impulses pass out over the white rami into the gangliated cord, thence upward by way of the stellate ganglion, or directly across to the heart, or possibly they reach the heart over both sets of fibers. *Brubaker in speaking of the sympathetic nerve supply of the heart says: "The fibers are peripherally coursing axons of nerve-cells situated in the ganglion stellatum. The nerve cells in the ganglion stellatum are in relation with small medullated nerve fibers which emerge from the cord in the anterior roots of the second and third thoracic nerves, pass through the white rami communicantes, and thence to the ganglion stellatum, where their end branches arborize around the nerve-cells."

These nerves with the pneumogastric, form the **cardiac plexuses.** The deep cardiac plexus lies between the trachea and the arch of the aorta and is formed by branches of all the cardiac nerves with the exception of the left superior cardiac branch of the superior cervical ganglion and the left inferior branch of the pneumogastric. Some of the branches

*Brubaker, p. 291.

of this plexus go to the anterior pulmonary plexus but a majority of them follow the coronary arteries and form the coronary plexuses, while some of them go to the right auricle. The distribution of the branches of the superficial plexus corresponds to that of the branches of the deep. A small ganglion called the cardiac ganglion of Wrisberg is found in this plexus near the ductus arteriosus. *Landois gives the following structures as belonging to the cardiac plexus: (a) "The right and left coronary plexuses, which convey the vaso-motor nerves of the coronary vessels through the vagus portion and the dilators through the sympathetic; and in addition contain sensory fibers derived from the vagus and passing principally to the pericardium. (b) The nerves embedded in the heart muscle and in the furrows, which are richly supplied with ganglia and which have been designated the automatic motor centers of the heart. The heart contains a circle of nerves richly supplied with ganglia at the edge of the interauricular septum and another at the junction of the auricles and the ventricles. Wherever the two meet they exchange fibers. The ganglia are for the most part found near the pericardium." Clinically, the lesions that affect the innervation of the heart are subluxations of the upper ribs, especially the fourth and fifth; the third, fourth and fifth thoracic vertebræ; the clavicle and lesions that affect it through effect on viscera and other structures, such as the diaphragm.

The point at which the heart can be most easily reached corresponds to the spine of the fourth thoracic vertebra. Manipulation directed to this point, that is passive movement of the vertebræ or the corresponding ribs will in the average case increase the heart rate. Pressure directed here will have the opposite effect. Lesions may inhibit or stimulate, hence a lesion that inhibits the nerves at this place will decrease the heart beat while an irritative one will increase the pulse rate. This is substantiated by an experiment performed by Dr. Fassett. As described by himself it was as follows: "The subject was a man thirty years of age, whose heart had at one time, shown some functional disorders but which for sometime had been practically regular although slightly faster than normal. The experiment was performed about 4:30 p. m. when the acceleration sometimes observed after a meal could be assumed to have passed away. The room was quiet and the subject had been in the room for over an hour so that the element of excitement

*Text-book of Human Physiology, p. 114.

could probably be neglected and, moreover, excitement is apt to cause an increase rather than a decrease in the number of heart beats. The subject had been lying on the table for half an hour so that the slowing with change of posture had probably reached its limit. With the subject still in the reclining posture an operator took his position with his hands so placed that, at the desired time, he could exert pressure on the region between the angle of the left fifth rib and the corresponding spinous process. The cardiograph was placed over the apex beat of the heart and the levers of the registering apparatus and the time marker were placed in contact with the smoked paper. In this case the latter was at a higher level. The drum was then set in motion and, after about a minute, pressure was begun in the region described and continued for about two minutes and then carefully removed. After about four minutes of observation, the levers were removed from the paper and the strokes of the time marker counted and divided into groups of 30 each. As these strokes were two seconds apart it is obvious that the space covered by each of these groups represents one minute of time. The number of strokes of the heart lever in the space covered by each of these groups were then counted with the following result:

First minute (during which pressure was begun) 74 beats; second minute, 71 beats; third minute (during which pressure was stopped) 66 beats; fourth minute, 64 beats.

If it were safe to draw conclusions from one experiment, this would show that pressure in the region of the fifth rib on the left side, exerted a marked inhibitory influence on the heart and that this effect is continued for sometime after the pressure is removed."* Observations of the writer have confirmed the above experiment and it is proven beyond a doubt that the heart can thus be affected by external manipulation. It seems that the **more nearly normal the heart, the less marked the effect obtained;** while in cases in which there is a functional affection, the effect is very well marked.

The **diseases** of the heart may be classified into those that result from causes that are external to the heart and into those that are due to changes in the heart itself. To the first belong the various functional disorders such as palpitation, in which the trouble seems to lie in the nervous mechanism that runs the heart.

Valvular disease and **angina pectoris** are due to changes in the

*Journal of Osteopathy, July, 1901.

heart itself. In both, the circulation and nutrition of the heart-muscle are affected so that it imperfectly performs its function. Such diseases result from the above named lesions because they affect the vaso-motor and nutrient nerves to the heart, since they come from the upper thoracic spinal cord. In practically all cases of heart disorder whether functional or organic, **tenderness** will be found **on pressure over the spines of the fourth and fifth thoracic vertebræ** and usually along the course of the **corresponding ribs** on the **left side.** The patient often complains of pains in the left side of the chest, pains of a shooting or stabbing character. Especially in angina pectoris, the left arm is involved and numbness is frequent in the little and ring fingers of the left hand. In functional disorders of the heart the most common lesion is a subluxation of the fourth or fifth ribs on the left side.

THE STOMACH.

The **stomach,** the most dilated part of the alimentary tract, lies when empty, in the left hypochondriac and epigastric regions. It is retained in position by its attachment to the diaphragm by means of the esophagus, to the liver by means of the lesser omentum and the hepatico-duodenal ligament and to the spinal column by means of the duodenum. When empty, it is in an almost vertical position but as soon as food is introduced into it, it rotates and descends so that it is more nearly horizontal. The larger and more capacious part is called the **cardiac end** and is directed toward the left side of the body. On account of the greater part of the stomach lying on the left, lesions affecting it are most frequently found on the left side. The constricted portion of the stomach lies when empty in the median line but when distended, crosses an inch or more to the right side. It is called the **pylorus,** because it guards the entrance into the duodenum. It is more anterior than the cardiac end and is thus exposed to a greater degree to trauma, such as a blow on the upper part of the abdomen.

The **pylorus** is produced by a thickening of the circular muscle fibers into quite a strong ring and the opening in the normal case, will scarcely admit the little finger, it being the most constricted portion of the alimentary canal. The **lesser curvature** of the stomach is directed towards the liver and marks the line of attachment of the lesser omentum. The gastric and pyloric vessels run along this curvature. The greater curvature is about three times as long as the lesser, and corresponds in

the greater part of its course, to the attachment of the great omentum. The right and left gastro-epiploic vessels lie in relation, between the layers of the omentum.

Fig. 153.—Showing the relation of the abdominal viscera to the back. Note the relation of the stomach to the spleen and kidneys.

The **relations** of the stomach are of importance on account of frequency of disease of parts in relation producing disturbances of function of it. **Anteriorly,** are the **diaphragm, liver** and **anterior abdominal wall.** Contraction of the diaphragm assists in the expulsion of the contents of the stomach. A prolapsed diaphragm affects the movements of the stomach and forces it to a lower level. The entire stomach can not be accurately percussed on account of the left lobe of the liver covering a part of it. In some dissections made by the writer, the left lobe was so markedly enlarged that it displaced the stomach backward and downward and produced a dull percussion note over the stomach. **Behind,** are the **pancreas, spleen, left kidney, left suprarenal capsule, diaphragm, aorta, inferior vena cava, vena azygos minor, transverse meso-colon** and the **great solar plexus.** Distension of the stomach whether from accumulation of gas or from over filling with food, will cause pressure on the structures in posterior relation, especially if the individual assumes the dorsal posture. Pressure on the veins interferes with the circulation and especially affects the drainage of the spinal cord. Pressure on the solar plexus is also a cause of much disorder, since it affects the entire circulation of the body. Insomnia and nightmare are due partly to the effects of pressure on the solar plexus from an overloaded stomach, the patient retiring before digestion was completed. **Superiorly,** are the **diaphragm, lesser omentum** and the **liver.** Liver disease such as an abscess, will directly affect the stomach from contiguity of tissue. **Inferiorly,** are the **transverse colon, spleen** and the **great omentum.** On account of contiguity of the structures surrounding the stomach, there may be dyspnea from pressure on the lung; and palpitation of the heart from pressure on it.

In pleural effusions it is often difficult to determine whether the trouble is in the stomach, kidney or in the pleural cavity. The effects on the **heart** are the most common and often a case of supposed heart disorder is in reality one of gastric disease. *Deaver says: "Because of the proximity of the stomach and heart, painful affections of the one may be mistaken for disease of the other, so justifying the advice that 'if the patient complain of his stomach, suspect heart disease; if he complain of his heart, suspect indigestion.' "

In distension of the stomach there is often found marked pain on the left side of the spine in the region of the vertebral ends of the fifth,

*Surgical Anatomy, Vol. III, p. 165.

sixth and seventh ribs and in the left shoulder. This is due to the pressure of the stomach on the nerves in posterior relation, principally the intercostals. When the stomach is distended with gas, the pressure is greatest on structures in relation with the cardiac end since the gas is only contained in that end.

The stomach is subjected so frequently to alterations of position that the external landmarks are of little value. Normally, the stomach may occupy any position from the primary vertical one when empty, to a position almost horizontal, immediately above the umbilicus. There are many factors responsible for this variation in position. Tight lacing is an important one. In such cases all the abdominal viscera are gradually but forcibly displaced downward producing a condition called **enteroptosis.** Overloading of the stomach causes it to be displaced downward from the increased weight. If this is frequently repeated, the stomach will remain in descent. Obstruction at the pylorus will cause distension and later on, displacement downward. In nearly all cases of chronic dyspepsia, general weakness and emaciation, the stomach is both dilated and displaced downward. It is well in every case of indigestion to ascertain the size of the stomach. This is best accomplished by percussion, which should be performed in different positions and especially in the upright, since the stomach will then settle to its maximum degree of descent. By causing the patient to drink a cup of water before the examination, the outline of the stomach can be ascertained by the succussion note. **Succussion** is present in most cases of catarrh of the stomach and furnishes a valuable diagnostic sign. If the tympanitic note of the stomach is found as low as the umbilicus or an inch or more to the right of the median line of the body or as far to the left as the mid-axillary line, the stomach is either very much enlarged or displaced.

In structure, the walls of the stomach are formed of the usual four coats, the serous, muscular, submucous and the mucous. The shiny appearance of the walls is due to the **peritoneum** that covers all parts with the exception of the curvatures and a small portion back of the cardiac orifice. The **muscular** coat consists of three layers arranged longitudinally, obliquely and in a circular manner. The circular are best developed at the pylorus. This arrangement of the muscle fibers permits of the **grinding** movements of the stomach. The blood-vessels and nerves break up in the submucous coat to be distributed to the walls of the stomach. The **mucous lining** of the stomach is of moderate con-

sistency, pink in color and thickest at the pylorus at which place it is most frequently diseased. When the stomach is empty, it is thrown into longitudinal folds or rugæ. The surface is covered with minute openings which are the mouths of the many glands embedded in the mucous membrane. The muscle fibers composing the walls of the stomach depend, like all muscle fibers, for their tone and nutrition on the condition of and connection with the **trophic cells,** located in the anterior horns of the grey matter of the spinal cord. If the circulation to these cells in the cord is impaired, or if the nerve connection is broken by a lesion, the walls of the stomach undergo relaxation and the stomach enlarges and becomes displaced downward. The condition of the back muscles in relation with the spines of the fifth, sixth and seventh thoracic vertebræ, furnishes a good clue as to the condition of the walls of the stomach as to their tone.

The stomach receives a rich supply of blood. All the **arteries** are ultimately derived from the **celiac axis.** The special branches comprise the **coronary,** the **pyloric** from the **hepatic, right gastro-epiploica** from the gastro-duodenal and the **left gastro-epiploica** from the splenic and the **vasa brevia** branches of the splenic. These arteries run along in the omenta that is, along the curvatures of the stomach, lying at first beneath the peritoneum but they very soon pierce the muscular coat and break up into innumerable branches. On account of the fact that the blood supply comes from several arteries instead of one as in the case of the small intestines and colon, gangrene is not so likely to result from injury of the part. The size of these arteries of the stomach, is controlled by the branches of the celiac plexus of nerves, which sends out filaments along with all the branches of the celiac axis, that is over the splenic, gastric and hepatic arteries. The impulses come originally from the fifth, sixth and seventh segments of the thoracic spinal cord. They pass out over the white rami into the gangliated cord and on through it by way of the great splanchnic nerve, to the solar plexus and particularly to the lower part or celiac plexus. It is an established fact that lesions at the fifth, sixth and seventh thoracic vertebræ produce vascular disturbances of the stomach. The explanation is that vaso-motor, as well as other impulses intended for the stomach, pass by way of the nerve filaments that go to form the great splanchnic nerve. These nerve filaments pass through the intervertebral foramina and are subject to pressure even in the slightest lesion, thickening of the liga-

ments or deviation. Consequently the vaso-motor impulses for the blood-vessels dilate. The pressure exerted by the subluxation of the vertebra, will affect the passing in and out of the blood that nourishes and drains the nerve-cells in the cord from which the impulses arise that supply the stomach, therefore disturbance of function of the stomach must follow. These lesions only predispose to disease by causing a weakening of the viscus thus making it possible for trivial exciting causes to become effective.

The **veins** in a way correspond in arrangement to the arteries. The important feature of them is the fact that they empty directly or indirectly into the portal vein. As a result of this, practically **all the blood from the stomach passes through the liver before it gets to the heart,** consequently any **obstruction in the liver** such as a congestion, whether from overeating or from lesions or disease, **will produce a passive congestion in the stomach.** From this it follows that in all cases of liver disease there is stomach disorder. These veins are probably supplied with vaso-motor nerves that are continuations of those that supply the portal vein, but this has not as yet been proven experimentally. The **lymphatic** vessels accompany the veins and empty into glands lying along the curvatures and at the cardiac and pyloric ends.

The **nerve supply** of the stomach is derived from the pneumogastric and sympathetic branches of the solar plexus. These branches form a plexus between the layers of muscle fibers and immediately under the submucous coat. Large ganglionic nerve cells are found in connection with these fibers, the whole constituting Auerbach's and Meissner's plexuses. The filaments that form that part of the solar plexus taking part in the innervation of the stomach, are derived ultimately from the thoracic spinal cord, the fifth, sixth, seventh and eighth segments, but especially the sixth. The impulses pass out of the spinal cord by way of the anterior root, pass into the common trunk, white ramus, gangliated cord and on through it by way of the splanchnic nerve to the solar plexus. In short, there is a direct line of communication existing between the spinal cord and the stomach and any interruption in the form of a lesion will affect the function of the stomach.

The motor impulses to the stomach come principally from the pneumogastric but some are furnished by the splanchnic nerves. *Starling says: "According to Schiff, motor fibers also reach the stomach

*Schafer's text-book of Physiology, Vol. II, p. 324.

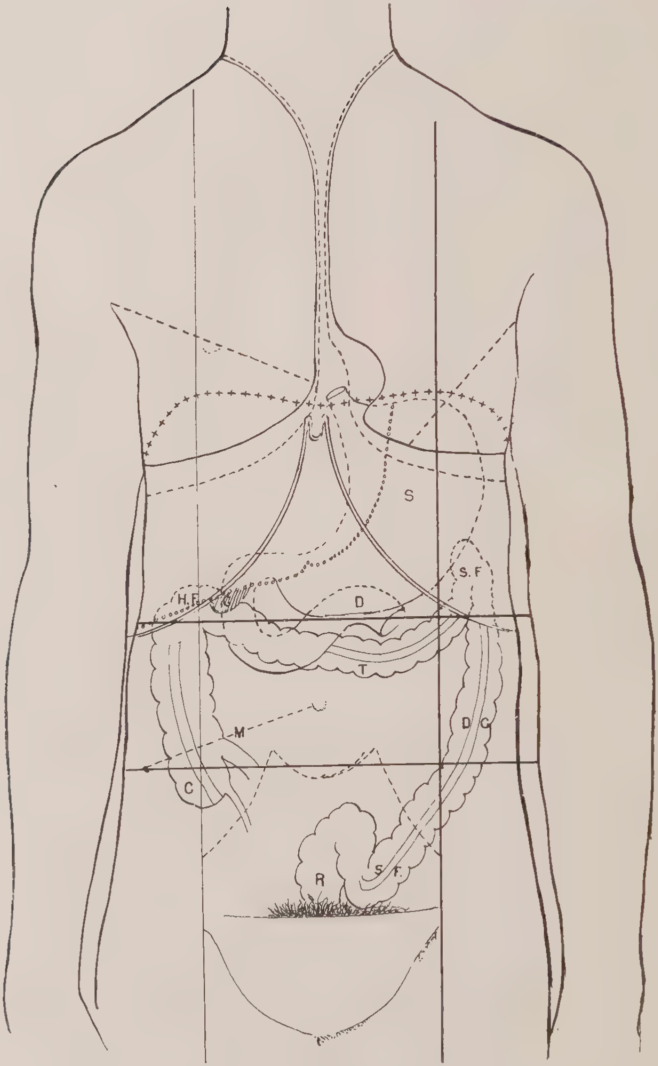

FIG. 154.—Showing the relations of the stomach and colon to the regions of the abdomen; S. stomach; D. duodenum; H. F. hepatic flexure; S. F. splenic flexure; T. transverse colon; M. McBurney's point; C. cecum; D. C. descending colon; S. F. sigmoid flexure; R. rectum. The dotted lines indicate the relations of the liver and pleura.

from the sympathetic chain, by way of the splanchnics. Morat also observed one case in which the rhythmical contractions of the stomach (and intestine) were augmented on stimulation of the splanchnics." The **splanchnic** nerves to the stomach are regarded by most observers as inhibitor in action that is, stimulation of them lessens the movements of the stomach. Judging from the effects of lesions, the splanchnic nerves are motor to the stomach, for irritative lesions along the mid-dorsal region, increase the movements of the stomach and certain forms of manipulation in this region, also affect the peristalsis of the stomach. Either this is true, or else the splanchnic is closely associated with the vagus so that stimulation of it will increase the activity of the vagus. In either case, it is a well known fact that lesions that are irritative in character, along the mid-dorsal region, increase the activity of the stomach while lesions that are inhibitory that is, paralytic in character, decrease the peristalsis of the stomach; these effects presumably being through the splanchnic nerves. The **sensory** nerves to the stomach according to Head, are derived from and "run in the sixth, seventh, eighth and ninth dorsal nerve-roots, the cardiac end being especially associated with the sixth and seventh, and the pyloric end with the ninth roots." The pneumogastric nerve also furnishes sensory fibers to the stomach. Sherrington says: "*As to the sensory nerve channel for the local sensation of hunger, likely enough it is the vagus but very possible the stomach receives nerve fibers also from the thoracic spinal ganglia, via the rami communicantes." The **vagus** supplies **secretory** fibers to the glands of the stomach. The splanchnic nerves also have to do with gastric secretion possibly more through the blood supply than through the so-called secretory nerves. Secretion depends to a great extent on the kind and amount of blood supplying the gland and since the splanchnics control the blood-supply to the glands of the stomach, they also control to a large extent, the amount of secretion. Congestion of the mucous membrane of the stomach causes an increase in secretion regardless of the cause of the increased amount of blood. †"Grutzner observed in a dog that the mucous membrane secreted continuously under the influence of a chronic gastric catarrh, but the gastric juice was deficient in pepsin, cloudy, viscous, less acid, even alkaline. The introduction of food did not modify the secretion; the stomach, therefore, never actually comes to rest." This offers an explanation

*Schafer's text-book of Physiology, Vol. I , p. 991.

†Text-Book of Human Physiology, Landois, p. 340.

of indigestion from congestion of the mucous membrane of the stomach. The lesions along the spine are the important causes of this secretory disorder since they primarily cause the congestion.

The **trophic** nerves of the stomach walls are the splanchnics. They also are intimately associated with the vaso-motor nerves. It seems that each muscle fiber of the stomach is connected with a cell in the anterior horn of the grey matter of the spinal cord, especially the sixth thoracic segments. These cells control the tone and nutrition of the muscle fibers. The connection is by way of the splanchnic nerves. This connection is broken or impaired by a lesion that lessens the size of the foramen through which the fibers, hence the impulses, pass. Any subluxation of vertebræ in the middle dorsal region, will lessen the size of the foramina, hence is responsible for weakness of the walls of the stomach, which is the most common of all disorders of the stomach.

The **vaso-motor** nerves are the splanchnics. Lesions that inhibit them produce dilatation of the vessels supplied by them and congestion is the result. After reaching the solar plexus by way of the splanchnics, the vaso-motor impulses reach the blood-vessels of the stomach by way of the **hepatic, splenic** and **gastric plexuses,** branches of the celiac. The walls of the stomach contain automatic ganglia that control their tone. These are connected with the pneumogastric and splanchnic nerves.

The higher **centers** that control the degree of contraction of the cardiac end, the body of the stomach and the pyloric end, are located respectively in the posterior quadrigeminal bodies, corpora quadrigemina, and in the cortex, the path being along the pneumogastric. Dilatation centers are located respectively in the corpus striatum and upper part of the spinal cord for the cardiac orifice; the upper cord for dilatation of the body of the stomach; while the center for dilatation of the pylorus corresponds to the centers that control constriction of the cardiac orifice, viz., the corpora quadrigemina. A majority of the impulses connecting these centers with the stomach, pass through the spinal cord and out over the splanchnics, hence are affected by spinal lesions and can be reached by spinal treatment. This is of value in the treatment of gastric disorders, such as obstruction of the pylorus and the accumulation of secretions and food in the cavity of the stomach, from deficient peristalsis. The best results can be obtained by the correction of lesions that interfere with the action of these centers but in some

cases inhibition applied to the left side of the spinal column at about the fifth or sixth thoracic spine, will cause the pyloric end to dilate. Pressure applied directly over the pyloric end of the stomach and kept up for a few minutes, has a quicker effect although it is only temporary but often long enough to relieve.

The **stomach** acts as a **reservoir** for the ingested food, assists in digestion by its movements and secretions, and aids in absorption. These functions are affected by lesions that weaken or cause spasmodic contraction of the walls of the stomach, thereby increasing or decreasing the size of the cavity; by lesions that interfere with the motor nerves to the stomach which result in perverted peristalsis; by lesions that affect the secretory and vaso-motor nerves thereby interfering with secretion and nutrition; and by disturbances of absorption. The first is represented by the distended stomach, the second by imperfect mixing of the food, the third by disturbances of secretion, hence indigestion as in gastritis and catarrhal conditions in which there is succussion. Lesions of the fifth, sixth, seventh and possibly the eighth thoracic vertebræ and the corresponding ribs of the left side, disturb these functions by changing the size of the intervertebral foramina so that the impulses to the stomach are affected, usually inhibited; by disturbing the nutrition of the nerve cells in the spinal cord that give rise to the impulses that pass over the nerves that supply the stomach; or these lesions stimulate or inhibit the nerves after they have emerged from the spinal foramina. Indirectly these lesions and others, may affect the functions of the stomach by disturbing the position or circulation of other viscera that are in relation as for example, the liver. These lesions affect the stomach in various ways. They may disturb the tone and nutrition of the muscle fibers, the size of the blood-vessels, the secretory nerves and consequently there are gastroptosis, gastritis, and catarrh.

*McConnell states in experiments on dogs in which lesions of the spine were produced (fourth, fifth articulations). "Careful chemical analysis of the stomach contents of the dog before and after production of the lesions showed a marked difference in the chemical reaction. The following deductions as to the stomach may be drawn from the analysis and experiments:

1. The muscular action of the stomach is lessened.

*Journal A. O. A., Vol. 5, p. 17.

2. The secretions of the stomach are decreased.

3. The physiological and mechanical functions of the stomach are retarded.

The microscope reveals intra-cellular congestion and ecchymoses of the stomach tissues and beginning degeneration of the glandular cells."

THE LIVER.

The **liver** is the largest gland in the body, weighing, on an average, four pounds. It is situated in the right hypochondriac and epigastric regions and may extend across to the left hypochondriac region. In the normal case it seldom extends more than two inches across the median line of the body but it is the exception for it to be normal in size. The writer has been surprised at the frequency of enlargement of the liver in the cadavers dissected at the school with which he is connected. It is the exception for a normal liver to be found and sometimes it is twice the size of the average or normal.

In the **infant,** the liver is proportionately much larger than in the adult and this should be considered before giving a diagnosis of enlargement of the liver. It is divided by the falciform ligament into **two lobes,** the right and left. In addition there are the Spigelian, caudate and quadrate lobes.

The **anterior** border is thin and sharp and extends slightly below the costal arch, when the patient is in the erect posture. If it extends further than this, it is indicative of enlargement unless it has been forced downward from the wearing of tight clothes. This border is notched to the right for the gall-bladder and to the left, for the separation of the right and left lobes.

The two **posterior** borders are grooved for the inferior vena cava and are in relation with the spinal column. The right extremity is thick and blunt, it contrasting with the thin, flat extremity on the left.

The **superior** surface is very smooth and convex, conforming to the arch of the diaphragm. It is covered by peritoneum and has a shallow depression on the left lobe for the heart.

The **inferior** surface is irregularly concave, consists of three parts, the quadrate and left lobes and the under surface of the right, and is covered with peritoneum except in relation with the gall-bladder and at e point where the lesser omentum leaves the liver. On this surface are

to be found the remains of the umbilical vein, now the round ligament, an impression for the stomach, a fossa for the gall-bladder and impressions for the hepatic flexure of the colon, right kidney and descending part of the duodenum.

The **posterior** surface is in relation with the spinal column. The

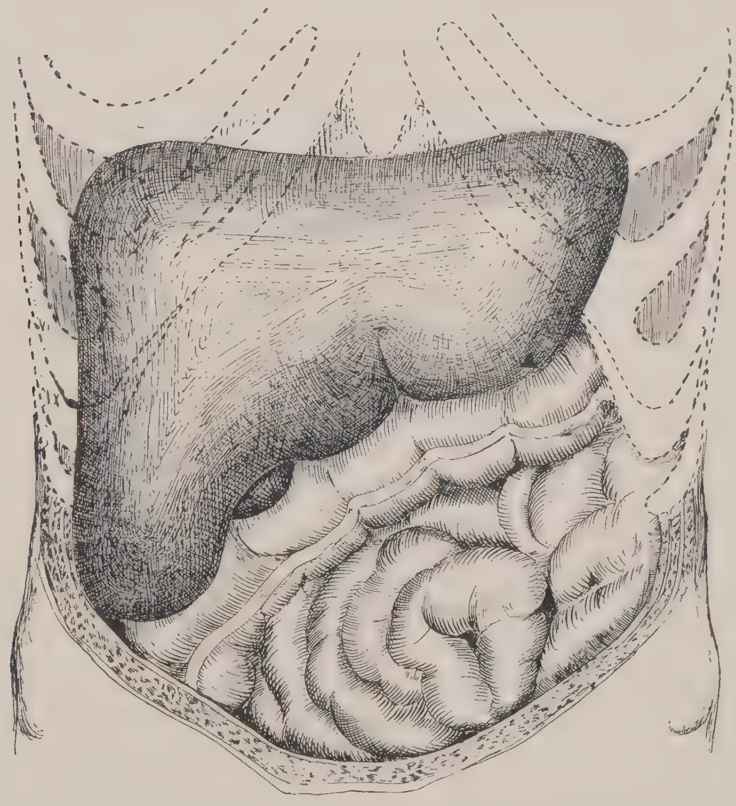

FIG. 155.—Showing a hypertrophied liver. Drawn from a dissection made at the A. S. O.

Spigelian lobe is opposite the bodies of the tenth and eleventh thoracic vertebræ, and the right crus of the diaphragm. It is connected with the right lobe by means of the caudate lobe. The fissures are arranged according to Morris, like the capital letter. H. The umbilical, a part

of the longitudinal fissure, and the fissure of the ductus venosus forming one side; the transverse bar of the H, being formed by the transverse or portal fissure, while the remaining part of the letter is formed by the fossa of the gall-bladder in front and the fissure of the vena cava behind. These are of little importance except from a surgical viewpoint as in operations on the gall-bladder and in abscesses. The ligaments are formed from peritoneum, except the round. They are all attached to the diaphragm with the exception of the round, which being the remains of the umbilical vein, is attached to the umbilicus. The peritoneal ligaments are the coronary, two lateral and the broad or falciform. These ligaments in conjunction with the blood-vessels support, or rather suspend, the liver.

On account of the frequency of enlargement of the liver, its relations are of marked importance on account of the effects on structures and viscera that are in relation.

Anteriorly, the abdominal wall and the diaphragm are in relation. Blows on the abdomen in this region may injure the delicate, friable tissue of the liver. A great many cases of abscess of the liver are due to direct injury. Although only a part of it extends below the costal arch, all of this portion is subject to injury from a blow on the part or from a hard treatment. **Superiorly,** is the diaphragm and back of it, the lungs. In abscess of the liver, the pus may burrow through the diaphragm into the lungs and be expectorated. This often gives rise to errors in diagnosis unless the relations of the lung and liver are considered. Liver disorders sometimes give rise to a chronic cough, popularly called a liver cough. It is the result of pressure exerted on or irritation of, the diaphragm and the lung, from an enlarged or diseased liver. In marked enlargements of the liver, the contour of the abdomen is changed and the action of the diaphragm interfered with.

Posteriorly, are found the lower end of the esophagus, tenth and eleventh thoracic vertebræ, crura of the diaphragm, right supra-renal capsule, right kidney, aorta, inferior vena cava, the great nerve plexuses of the abdomen and the vena azygos major vein. From this it follows that enlargement of the liver, or lying in the dorsal position for any length of time, will affect by pressure, the above named structures. Perhaps the most important effect is that on the gangliated cord and its branches and the veins in posterior relation.

Below the liver are the stomach, hepatic flexure of the colon, the

right kidney, and the first and second portions of the duodenum. Enlargement of the liver causes an encroachment on these organs. Tight lacing has a similar effect by crowding the liver downward. The normal liver extends as high as the fourth costal space in the mammary line on the right side. Posteriorly it reaches to the tenth rib. "*Its lower margin corresponds superficially to the eighth rib in the axillary line, tenth dorsal vertebra behind, and in front to a line from the tip of the ninth right costal cartilage to the eighth left costal cartilage. At a deep level it extends to the eighth rib behind."

The outline of the liver is best obtained by percussion while the patient is in the erect posture, since, in this position, the organs are more nearly in their proper relations. On palpation, the condition of the liver to a certain extent, can be determined, and especially so if it is enlarged, in a position of descent and tender.

The **blood-supply** of the liver is derived from two sources, the hepatic arteries from the celiac axis that carry nutrition to the substance of the liver, and the portal veins that carry blood to the liver for elaboration by the action of the liver-cells. The **hepatic** arteries pass up between the two layers of the lesser omentum and divide into two branches, one for each lobe. It enters the left end of the transverse fissure, gives off branches to the capsule of Glisson, the fibrous coat and the gall-bladder. It then divides and subdivides within the substance of the organ. This artery receives its innervation from the hepatic plexus of nerves and ultimately from the spinal cord by the way of the great splanchnic nerve. In disorders characterized by disturbances of nutrition of the substance of the liver, the hepatic arteries are at fault but if the symptoms are those of jaundice, the portal system is affected.

The **portal vein** is formed by the splenic, mesenteric, pancreatic and gastric veins. The portal system is peculiar and bears a close relation to the arterial. Practically all the blood from the digestive tract passes through the liver to be purified or otherwise acted on by the liver. Any obstruction in the liver will cause the blood to back up and accumulate in the viscera drained by the portal vein, hence any disease of the liver characterized by congestion, predisposes to or actually produces, disorder of the stomach, pancreas, spleen and small and a part of the large intestine.

The **nerve supply** of the portal vein has been pretty well investi-

*Eisendrath, Clinical Anatomy, p. 200.

gated, in fact, more fully than that of any other vein. *"Bayless and Starling localize the outflow of vaso-constrictor nerves to the portal system in from the third to the eleventh anterior thoracic roots. By excitation of the eighth to the eleventh roots, they obtained, first, a rise of pressure in the portal vein due to constriction of the mesenteric arteries, forcing blood on into the portal vein; secondly, a fall due to the diminished flow of blood through the mesenteric arteries; and lastly, a rise due to constriction in the hepatic branches of the portal vein." In another place the same investigator says: "By stimulation of the thoracic sympathetic cord, blood was actively expelled from the liver. If the hepatic nerves were divided, this stimulation of the sympathetic, by causing contraction of the spleen, produced dilatation of the liver. The liver is exceedingly vascular, and forms an enormous reservoir for the venous blood at periods when the diastolic filling of the right heart is impeded; for instance, during an intense muscular effort, or a prolonged dive under water. The portal circulation is aided considerably by the action of the respiratory pump. The abdominal wall compresses the blood, while the thorax sucks the blood from the liver. The circulation through the liver is thus greatly accelerated by muscular exercise." The above statements go to prove that there is a connection existing between the spinal cord and liver and that stimulation applied to the middle thoracic nerves, affects the blood-vessels of the liver. The application is that a lesion either stimulates or inhibits, and that a lesion in the middle dorsal region will affect the circulation through the liver. The explanation is that it either stimulates or inhibits the passing of nerve impulses from the spinal cord to the liver, they passing by way of the splanchnic nerves. These lesions act as predisposing causes to liver disease in that they impair the hepatic circulation. Undoubtedly the frequency of disease of the liver is to a great extent due to dietetic errors and abuse and in many cases, to these lesions that so weaken the vessels of the liver that the abuse readily affects the organ. The most important of these lesions are those that affect the **seventh** and **eighth thoracic vertebræ.**

The blood is gathered up by the radicles of the hepatic veins and emptied into the inferior vena cava. Lying on the back has a tendency to produce pressure on these veins and thus interfere with the drainage.

The **lymph vessels** empty into glands that are around the pancreas, in the omentum, while the superficial, empty into the anterior mediastinal

*Hill, Schafer's text-book of Physiology, p. 140.

glands and into glands in the small omentum. The practical part of this is the fact, that it is the **exception for the omenta to be in a normal position and in displacements of it, the lymph drainage of the liver is obstructed.** Some of the lymph vessels empty into the lumbar glands on the right side.

The **nerve supply** of the liver is from the celiac plexus, the pneumogastric, especially the left, and from the phrenic. The impulses pass from the spinal cord by way of the sixth, seventh and eighth thoracic nerves into the great splanchnic, thence through the celiac plexus and over the hepatic, to the liver. They unite with the filaments from the pneumogastric. They are vaso-motor, trophic and possibly secretory in function. *Landois says: "The celiac plexus sends trophic and vaso-motor nerves to the liver. Destruction of this plexus therefore causes degeneration of the liver-cells, and dilatation of the hepatic artery. The pneumogastric nerve supplies dilator-fibers to the vessels, and the greater splanchnic motor branches to the muscles of the bile ducts." As stated above, lesions of the spine affect the innervation of the liver because as Brubaker states, the liver is supplied with nerves derived from the central nervous system and the fibers pass through the thoracic intervertebral foramina. Filaments of the right phrenic pass through the coronary ligament to the right lobe of the liver after it passes through the diaphragmatic plexus. †McClellan says: "The pain which is felt at the top of the right shoulder in disease of the liver is conjectured to be due to the reflex influence through the phrenic nerve to the third and fourth cervical nerves, whence the supra-acromial nerves are also derived." A better explanation is that the same segments of the spinal cord that give rise to the fibers of the splanchnic that supply the liver and stomach, also give rise to the nerves that supply the muscles and integument of the parts involved in this liver pain, that is the fifth and sixth thoracic nerves. The pain seems to be under the scapula rather than in the region of the acromial process.

The splanchnics, contain afferent fibers that convey **sensory** impulses from the liver to the spinal cord and are involved in all painful affections of the liver. On account of the close connection existing between these and the cerebro-spinal nerves on the right side, the pain is referred to the integument over the liver in many diseases of the liver.

*Text-book of Physiology, p. 311.

†Regional Anatomy, p. 56.

In structure, the liver is composed of an enormous number of minute polyhedral cells which are imperfectly separated from each other. The blood-vessels, hepatic ducts, and lymphatics are in the connective tissue that surrounds each cell. The liver is very friable thus easily torn and bruised. Hemorrhage from a tearing of the substance of the liver, is profuse as in trauma, the result of a bullet wound or a fractured rib. It is sometimes bruised by injudicious treatment in which it is too severly massaged.

The important **functions** of the liver are the secretion of bile, the storing up of glycogen and the formation of urea. It also has something to do with the formation and destruction of the red blood corpuscles. These functions are dependent on the amount and character of the blood carried to the liver and the condition of the nerves supplying it. Digestive disorders affect the quality of the portal blood and thus affect the function of the liver. Overeating produces an excessive amount of portal blood consequently the liver is congested.

The above mentioned lesions affect the nerve and blood supply and are thus the important predisposing causes of liver disease. The lesions that are most frequently associated with disturbances of the liver are subluxations of the **sixth, seventh** and **eighth,** thoracic vertebræ; displacement of the corresponding **ribs,** particularly on the right side; contracture of the muscles in the mid-dorsal region and displacement or disease of the viscera drained by the portal vein, thus affecting the character of the blood that is carried to the liver. The lesions of the ribs on the right side result in many cases, in pressure directly on the liver as in tight lacing. As in most effects of lesions, the above produce circulatory disturbances in the liver and consequently any sort of disturbance of function will follow, it depending on the degree of the disturbance and the exciting causes; normal circulation being absolutely necessary to perfect function.

The **gall-bladder** is a membranous sac that acts as a reservoir for the bile. It is lodged in a shallow fossa on the under surface of the liver. The wide end or fundus is lowest and reaches to the lower edge of the liver. It is the part that, in favorable cases, can be palpated and being the lowest part, contains the residue of the bile and the calculi that have not already passed into the duct. The constricted portion or neck is somewhat curved which is continued into the duct. This

is of importance in the working of gall-stones out of the duct. The **cystic** and **hepatic ducts** join at an acute angle to form the common duct. The gall-bladder and these ducts have muscle fibers and nerves. The action of them seems to be a reflex one. Pressure exerted on the bladder will not cause emptying of its contents by the mechanical force exerted, but will reflexly cause relaxation of the neck, and contraction of the fundus, thus permitting of evacuation of the contents.

Fig. 156.—Showing hypertrophy of the liver with ascites. The swelling extended to all parts of the abdomen and was so distressing that it was necessary to resort to repeated "tapping." (From photo).

The innervation is from the cystic plexus, the **eighth** and **ninth thoracic segments** being the particular source of the impulses. The great splanchnic nerve is the inhibitor nerve to the gall-bladder and the ducts, while the pneumogastric seems to be the motor nerve. "Stimulation of the central end of the splanchnic, causes relaxation of the ducts and bladder, while stimulation of the central end of the pneumogastric nerve causes their contraction, together with relaxation of the

sphincter of the duodenal orifice." (Landois). The ducts often become partly occluded by the accumulation of mucus in them and can best be removed by pressure directed along their course, they reaching almost to the umbilicus. In hepatic colic, pressure over the common gall-duct will cause dilatation and at the same time produce a numbing of the sensory nerves supplying the part. Lesions of the spinal column that affect the substance of the liver, affect the gall-bladder and the character of the bile. These lesions affect the gall-bladder and its ducts through disturbance of the splanchnic nerves, hepatic and cystic plexuses, the pneumogastric through the hepatic plexus, and through the cystic artery, a branch of the hepatic. In short the various impulses that pass to and from the gall-bladder and its ducts pass through the seventh, eighth and ninth thoracic intervertebral foramina, and since these foramina are usually lessened in size by a lesion of the corresponding vertebræ and ribs, therefore such lesions would directly affect these impulses and disturbance of function result. Inhibition applied at the exit of the nerve from the intervertebral foramen, will often relieve the pain in gall-stone colic.

THE PANCREAS.

The **pancreas**, is a long gland of a grayish color that is situated in the epigastric and left hypochondriac regions, deeply placed in relation with the bodies of the first and second lumbar vertebræ. It varies much as to size, the average length being about six inches, and is about three quarters of an inch thick. During digestion it becomes engorged with blood and is considerably larger than at other times. The **head** of the pancreas fills up the concavity between the descending and inferior parts of the duodenum and is attached to the walls of the duodenum. The **body** lies on the aorta, the left crus of the diaphragm and the left suprarenal capsule, and is covered by the meso-colon. The **tail** of the pancreas is in relation with the left kidney and rests on the spleen. It lies entirely back of the peritoneal cavity, but has a capsule that sends processes between and around the lobules that compose it. The **surfaces** are moulded to conform to the adjacent structures.

From right to left, it is in relation with the duodenum, superior mesenteric vessels, transverse colon, meso-colon, superior and inferior pancreatico-duodenal vessels, inferior vena cava, left renal vein, aorta, common bile duct, pyloric end of the stomach when it is distended, bodies

of the first, and a part of the body of the second lumbar vertebra, left crus of the diaphragm, left kidney and its vessels, left suprarenal capsule, and the spleen. From these relations it can be seen that any enlargement or disease of it will affect important structures. The **posterior surface** is closely adherent to the structures in relation while the anterior, is covered by the peritoneum.

The principal **duct** traverses the entire length of the organ and

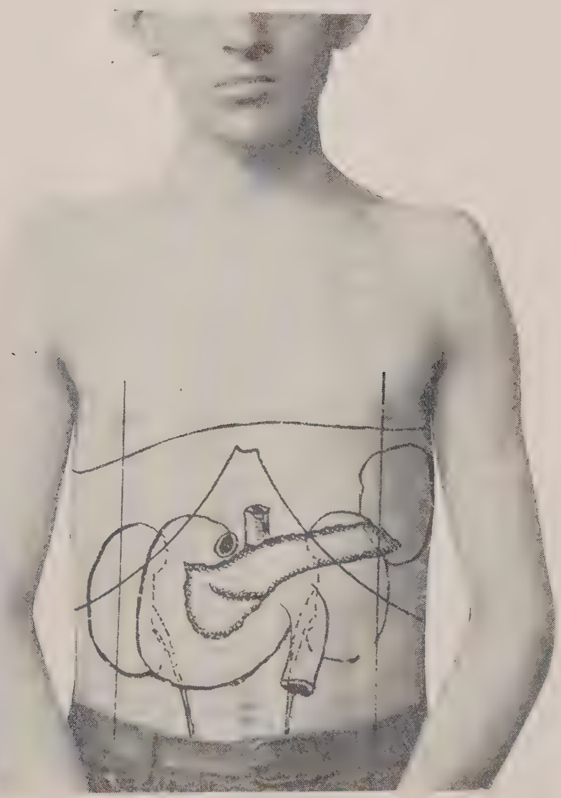

FIG. 157.—Showing the surface markings for the abdominal viscera. Note the umbilicus and the ensiform cartilage; the center of the line connecting these points, marks the place of tenderness in practically all cases of organic disease of the stomach and pancreas.

empties into the common bile-duct which opens into the duodenum at a point near the junction of the first and second portions.

The writer has noted that in practically all cases of indigestion, that there was an **enlargement,** about midway between the ensiform cartilage and the umbilicus. This enlargement is greatest in organic diseases of the stomach as in gastric ulcers. It is also present in cases of gastritis, the more severe the case the greater the enlargement. I have seen many cases of gastric and pancreatic disorder that were diagnosed as cancer of the stomach. The enlargement at the above described place, is principally in the **pancreas,** some of it being in the pyloric end of the stomach. This enlargement is always tender on pressure. It lessens in size under treatment in proportion to the relieving of the primary disease.

Since **gall-stones** are found in the common, as well as the hepatic duct, they obstruct the outflow of pancreatic juice and thus affect the function of the pancreas as well as that of the intestines. On account of the relation of the head of the pancreas to the common bile ducts, disease of it as in carcinoma will cause jaundice. "Calculi form in these ducts, giving rise to colic resembling that of gall-stones, with fat diarrhea and diabetes." (Eisendrath).

The **blood-supply** of the pancreas in very abundant and the arteries tortuous. It is derived from the pancreatic branches of the splenic, and from the superior and inferior pancreatico-duodenal arteries which are derived respectively, from the hepatic and the superior mesenteric.

The **innervation** of these arteries supplying the pancreas, is from the splanchnic, according to the experiments of Francois-Franck and Hallion. *"They obtained evidence of vaso-constriction on excitement of the splanchnic nerves on either side, and traced the origin of the constrictor fibers to the anterior roots from the fifth thoracic to the first lumbar nerves. Expansion of the pancreas seemed to follow excitation of the peripheral end of the vagus. Reflex constriction of the organ was produced by stimulation of any sensory nerve, or of the cerebral cortex; reflex dilatation, by excitation of the central end of the vagus." From clinical observations it seems that the vaso-motor nerves come mostly from the sixth to the eighth thoracic segments judging from the effects of lesions on the circulation of the pancreas.

The **venous blood** is gathered up by the pancreatic veins which

*Schafer's Text-book of Physiology, p. 164.

empty into the portal, that is, all the blood that passes through the pancreas must pass on through the liver before it reaches the heart. As a result of this as in the case of the stomach, any liver disorder will cause more or less disturbance in the pancreas.

The **nerves** to the pancreas are arranged in plexuses that follow the arteries, that is the hepatic, splenic and the superior mesenteric. These plexuses are derived from the solar and ultimately from fibers of the pneumogastric and splanchnic nerves. They are principally vaso-motor and secretory in function, however the amount of secretion seems to depend most on the amount of blood in the pancreas. Pain impairs the character of the pancreatic secretion and thus tends to, and in many cases actually does, produce indigestion.

The **functions** of the pancreas are evidently very important but little understood. It has to do with the digestion of starches, proteids and fats in the intestine. These functions are due to the ferments of the pancreatic juice, amylopsin, trypsin and steapsin. "Casein is almost wholly digested by trypsin." A patient that can not digest cheese probably has some disorder of the pancreas. Some believe that the pancreas secretes a ferment that is for the purpose of destroying the sugar in the blood, others that the secretion holds in solution the sugar. That the pancreas has something to do with the sugar of the blood is beyond question, since in disease of the pancreas, glycosuria is usually present. Lesions of the spine affect the functions of the pancreas by interfering with the innervation and blood-supply to it. The nerves are affected since the impulses come from the spinal cord by way of the great splanchnic, they passing through the intervertebral foramina in relation with the sixth, seventh and eighth thoracic vertebræ, and these are always lessened in size by the average lesion. Thus the impulses designed for the pancreas, are obstructed or in some way impaired. The blood-vessels are under the control of the sympathetic nerves supplying the pancreas and would thus be affected by the lesions named above. If the circulation of the pancreas is affected at all, the secretions of it are disturbed since normal secretion is dependent on a normal circulation. As a result of this secretory disturbance, intestinal digestion is interfered with.

Dr. Still has stated that the pancreas secreted a kind of fat or oil that had to do with holding the cholesterin and the other ingredients that go to form gall-stones, in solution. Whenever this secretion is

decreased or stopped, the **"chalky deposits"** form, and that by starting up again this secretion, these deposits can be dissolved. It seems that the secretion of the pancreas when normal, prevents the formation of gall-stones and from cases that I have seen Dr. Still treat, I am of the opinion that not only further formation of gall-stones can be prevented by restoring the normal functions of the pancreas, but that stones already formed can be dissolved, if the pancreatic secretions become normal.

The **important lesions** to be considered in addition to those mentioned above are lesions of the sixth, seventh and eighth ribs on both sides but especially on the left. The explanation of why such lesions affect the secretions of the pancreas must be that they in some way affect the function of the fibers of the great splanchnic nerve that supply the pancreas with vaso-motor and secretory impulses, which is certainly possible considering the proximity of this nerve to the ribs as well as the blood-vessels that supply not only the nerve, but the spinal and the gangliated cords that give rise to it.

THE SPLEEN,

The **spleen**—one of the ductless glands—is a somewhat elliptical shaped organ, situated in the left hypochondric region. It is about five inches in length, three or four inches in breadth and a little over an inch in thickness. It weighs on an average about seven ounces. It is placed obliquely in the side of the abdominal cavity, its long axis corresponding to the long axis of the tenth rib. Its upper end is attached to the diaphragm by means of the phrenico-splenic ligament and consequently the organ takes part in the respiratory movements of that muscle. This assists in the circulation of the blood through the organ and furnishes a valuable point in the differential diagnosis of splenic, from other tumors of the region, **tumors of the spleen moving during the respiratory** acts while tumors of parts not attached to the diaphragm are not changed as to position on contraction of the muscle.

The **outer surface** is in relation with the ninth, tenth and eleventh ribs being partly separated from them by the diaphragm and to a certain extent, by the lung. The pleura and peritoneum are also between the spleen and the ribs and thus are affected in lesions of the spleen and displacement of the ribs. On account of these relations excision, from the external aspect is impractical. The **inner surface** of the spleen is quite markedly concave and is in relation with the great cul-de-sac of

the stomach and the spleen. It is connected with the stomach by the gastro-splenic omentum and the splenic and vasa brevia arteries. Behind the gastro-splenic, is the lieno-renal ligament which connects the spleen with the kidney and through which pass the splenic vessels. Thus in displacement of the spleen or kidney these vessels will be affected. The **anterior border** of the spleen has a notch which is of value in diagnosing enlargements of the spleen from other tumors. In enlargement of the spleen, it is displaced forward and downward, often beyond the median line of the body. The **outline** of the **spleen** can best be obtained by percussion with the patient in the erect posture with the left arm extended over the head. It is almost completely enveloped by peritoneum, the folds of it serving to hold it in position. Accessory spleens are not uncommon, being characterized by globular masses of splenic tissue.

The **arteries** of the spleen are branches of the splenic that reach it by passing through the folds of the lieno-renal ligament, and breaking up into several twigs, pass into the spleen at the hilus. The **splenic vein** empties into the superior mesenteric which in turn empties into the portal.

The **nerves** of the spleen are derived from the splenic plexus which is formed from the celiac, the filaments following the splenic artery into the spleen. The nerve cells from which they arise are in physiologic relation with nerve-fibers (pre-ganglionic fibers), which emerge from the spinal cord in the anterior roots of the third thoracic to the first lumbar nerves inclusive, though they are found most abundantly in the sixth, seventh and eighth thoracic nerves. (Brubaker). The predominating center is in the medulla oblongata. Asphyxia causes a lessening in size of the spleen from the effects on the centers in the medulla. Stimulation of the nerves to the spleen at any part of their course, gives rise to a diminution in the volume of the spleen. Inhibition of them probably has the opposite effect although this has not been experimentally demonstrated. Lesions of the seventh, eighth and ninth thoracic vertebræ and the corresponding ribs on the left side, will affect these nerves thus producing a stimulation or inhibition of them which produces vaso-motor and other effects in the spleen. In most of the cases of splenic disorder seen by the writer, lesions in this region were important as etiological factors in the production of the disease and in proportion to the degree to which the lesion was reduced, the symptoms were re-

lieved. The **size** of the spleen varies considerably on account of the variation in the amount of blood that it contains. Enlargements are the most frequent of its affections. These are distinguished by movement with respiration,descent and gravitation to the right when the patient is turned on the right side, increased area of dullness, palpation of the notch on the under surface and by the fact that they are as a rule, painless. The causes are associated in some way with diseases that produce a marked toxemia such as syphilis, malaria, and Hodgkin's disease, while the above named bony lesions act as predisposing causes.

Experimentally, it has been shown that (in the dog) lesions of the fifth to the ninth ribs inclusive, cause enlargement of the spleen. McConnell has noted that it enlarged to "over twice the normal size" within two weeks after the ribs were subluxated. This was also found to be the case in subluxation of the corresponding vertebræ. These experiments are in accordance with the clinical observations of practitioners that have noted such cases.

The **functions** of the spleen are not well understood. The spleen can be removed from an animal with few, if any, immediate pathological effects. In such experiments it has been noted that the activity of the bone-marrow is increased and that the lymphatic glands enlarge. It is supposed to have to do with the formation of leukocytes and the destruction of functionally useless red-blood corpuscles. It is evident from the effects of disorder of it that it has something to do with the elaboration of the blood. In nearly all fevers, it becomes enlarged and tender to the touch. In some cases the splenic disturbances are effects of disease of other parts while in many they are the direct effects of lesions of the thoracic vertebræ from the seventh to the tenth, but more frequently, the result of lesions of the corresponding ribs on the left side.

THE SMALL INTESTINE.

The **small intestine** commences at the pyloric end of the stomach and extends to the cecum in the right iliac fossa. It is on an average about twenty feet in length and is divided into three parts, the **duodenum, jejunum** and the **ileum.**

The **duodenum,** so named from its length, it equaling the breadth of twelve fingers, extends from the pylorus to the left side of the body of the second lumbar vertebra, at a point in relation with the crossing of the intestine by the superior mesenteric artery. The duodenum has

the thickest walls, is largest and is more fixed than the other parts of the small intestine. It in turn is divided into three parts, the first or **superior** portion, the second or **descending** portion and the third or **inferior** portion. The first portion is entirely covered by peritoneum, passes to the right and backward beneath the liver and at the neck of the gall-bladder passes into the second part. It is in relation with the quadrate lobe of the liver, head and neck of the pancreas, pyloric end of the stomach, portal vein, the vena cava, bile duct and the gastroduodenal artery. These relations are of interest and importance, in the differential diagnosis of disease of this part of the small intestines.

The **second portion** of the duodenum passes from the neck of the gall-bladder, downward behind the transverse colon and ends at the right side of the upper part of the fourth lumbar vertebra. It is held quite firmly in its position by cellular tissue, this being necessary on account of the emptying of the bile and the pancreatic secretions into this part. It has in relation with it the hepatic flexure of the colon, the ascending colon, the right kidney, with its ureter and vessels, the liver and a part of the right psoas muscle. The common bile and pancreatic ducts lie in posterior relation to the first and second portions of the duodenum and affections of the one produce some effect on the other. These ducts empty into this portion of the duodenum about four inches below the pyloric end of the stomach. This point is of value in the treatment of hepatic colic whether from a mucous plug or from a gall-stone. Superficially, the point of entrance of these ducts is almost as low as the umbilicus in the normal subject and in the average patient, is even lower than the umbilicus.

The **third part** of the duodenum extends from the termination of the descending portion that is from the body of the third or fourth lumbar vertebra, to the left side of the body in relation with the pancreas at which place it passes into the jejunum. As it crosses the body of the second lumbar vertebra, it is firmly fixed to it by a sort of muscular band called the musculus suspensorius duodeni—a band of non-striated muscle fibers that has its origin from the left crus of the diaphragm and the tissues around the celiac axis. It is in relation with the vena cava, left renal vein, aorta, left psoas muscle and the crura of the diaphragm. At the point where the duodenum and jejunum meet, is a triangular fold or pouch and in some cases is the seat of **internal hernia.** These herniæ are more common than was formerly supposed and are responsible for

many painful derangements of the small intestines. They usually result from strong muscular efforts that markedly increase the intra-abdominal pressure and thus force a loop of the intestine through a fold or depression in the mesentery. By placing the patient in the Trendelenburg position and exerting gentle traction on the displaced part, relief can be given and in a short time the bowel replaced.

The **jejunum** is that part of the small intestine immediately beyond the duodenum. It is about eight feet in length and is attached to the posterior abdominal wall by the mesentery.

The **ileum** is about twelve feet in length and opens into the large intestine at the junction of the cecum and ascending colon. The arrangement of the coils of the small intestine varies, but generally the jejunum is to the upper left part and the ileum to the right lower part of the abdominal cavity. It is often the case that the small intestines get displaced downward and are thus **packed into the true pelvic cavity.**

In **structure, the walls** of the small intestines are composed of the usual coats, the serous, muscular, submucous and the mucous. The **serous coat** is incomplete in the duodenum but complete in all parts of the remainder of the small intestine. The **muscular** coat is thickest and strongest in the upper part and gradually becomes thinner as it is traced down the intestine. The **submucous** coat in the upper part, contains the glands of Brunner and in the jejunum and ileum, the solitary glands. The **mucous** coat is thickest above and is covered with villi. In this coat are found the Peyer's patches which seem to be primarily attacked in typhoid fever. They are especially large and prominent in the ileum. The valvulæ conniventes are formed from the mucous coat and are most developed in the jejunum.

The small intestines are protected against trauma by the sensitive and strong muscular abdominal wall. On the shortest notice the wall involuntarily contracts to resist the blow and in this way lessens and commutes the force. They are supported by the mesentery and the abdominal wall. The mesentery attaches them to the spinal column and affords a passage-way for the blood and lymph vessels. The abdominal wall is a very important factor in the support of them and in cases in which it is relaxed, the intestines are invariably in a state of **prolapsus** or descent.

The **mesentery** is a broad, triangular fold composed of two layers of peritoneum that connect the intestine to the posterior abdominal

wall, in an oblique line running from the left side of the body of the second lumbar vertebra to the right iliac fossa. The folds of the mesentery contain the blood-vessels that carry blood to and from the small intestine, the lymphatic vessels and glands, a considerable amount of adipose tissue and the intestine itself. These things are of importance in that displacement or torsion of the bowel, will result in obstruction of the blood-and lymph-vessels, hence congestion of the blood-vessels of the intestine.

Enteroptosis is very common and is an important predisposing cause of typhoid fever and other disturbances of the small intestine. In such a condition, not only are the vessels and nerves in the mesentery stretched but they are also partly or completely ligated and consequently, the circulation in and through the bowel becomes slower and the vitality thus lowered.

The **function** of the small intestine is that of digestion and absorption. Digestion is accomplished by the action of the secretions and the peristalsis. Most of the absorption takes place in the small intestine, especially that of the fats, proteids and the carbohydrates. Absorption depends more on the vascular condition of the walls of the intestine than on all other conditions. After all, **proper circulation** is the **most important of all things so far as the functions of the human body are concerned.**

The **blood-vessels** of the small intestine which are very numerous, are derived mainly from the superior mesenteric artery. The duodenum is supplied by the superior and inferior pancreatico-duodenal arteries, branches of the gastro-duodenal and superior mesenteric. These arteries pass between the two layers of the mesentery and give off branches—the vasa intestini tenuis—which form arches and finally reach the intestine as terminal arteries. While in the layers of the mesentery there is free anastomosis, they forming an intricate network or interlacement that to the naked eye appears to be marvelous. For the perfect functioning of the part, these blood-vessels must be free from obstructions since on account of the great number and size of the vessels, a marked stagnation will result from a twist of the mesentery, this causing congestion of the walls followed by perverted movements and secretions. This acts as a predisposing cause of microbic diseases of the small intestine, such as typhoid fever.

The **veins** are arranged similarly to the arteries, that is, they lie

between the layers of the mesentery and are thus subjected to a greater pressure from a twist of it than are the arteries because the walls are less resisting. The **vaso-motor nerves** for these vessels, the veins as well as the arteries, are derived from the plexus that surrounds the superior mesenteric artery. Landois says: †"The splanchnic nerve is also the vaso-motor nerve of all the arteries and veins of the small intestine, including the portal vein, thus controlling the largest vascular area of the body."

The **lymphatics** empty into the mesenteric glands. They are known as lacteals and begin in the villi and form into plexuses between the various coats of the wall. These vessels, like the blood-vessels, are contained between the layers of the mesentery and are thus subject to disturbances in displacement of the bowels. The mesenteric glands numbering from forty to one hundred and fifty, become tender and enlarged in inflammatory and other diseases of the small intestine. The lymph eventually reaches the receptaculum chili.

The **nerve** supply of the small intestine is derived from the solar plexus by way of the superior mesenteric plexus, the right vagus and from the plexuses of Auerbach and Meissner that are formed from the above. The pneumogastric seems to be the motor nerve to the intestine since experimentally stimulation of it is followed by increased peristalsis. It also contains some inhibitor fibers according to some investigators. According to Landois the splanchnic nerves are the inhibitor, motor, vaso-motor and sensory nerve to the intestine. He says: "The splanchnic nerve is the inhibitor nerve for the intestinal movements, but only so long as the blood in the capillaries has not become venous while the circulation in the intestine remains undisturbed. If the latter condition has arisen, irritation of the splanchnic causes increased peristalsis. If arterial blood be introduced, the inhibitory action is prolonged. O. Nasse believes that it may be concluded from the experiments that, in addition to these readily exhausted inhibitory fibers, paralyzed by venosity of the blood, there are present motor fibers that are excitable for a longer time, inasmuch as stimulation of the splanchnic nerve after death always causes peristalsis of the stomach and intestines, as does stimulation of the pneumogastric nerve."* This conforms to the clinical experiences of the osteopathic practitioner and working on this plan the

*Landois' Physiology, p. 288.

movements of the small intestine can to a great extent, be controlled by manipulation of the spine by which the splanchnic nerves are stimulated or inhibited. Lesions of the spine that affect the circulation of the blood through the small intestine affect the function of the nerves innervating it, since according to the above experiment, the function of the splanchnic nerve is governed by the condition of the blood. The nerve impulses that are destined for the small intestine originate in the middle spinal cord, the eighth, ninth and tenth thoracic segments being the principal ones from which they arise. Lesions of the vertebræ corresponding to these segments intercept, or otherwise affect, the passing of the impulses to and from the small intestine and the spinal cord, and thus predispose the intestine to disease by lowering its vitality. As has been mentioned before, these lesions of the spine affect the spinal nerve, hence its various functions, by **lessening the size of the intervertebral foramina** thus producing pressure directly on (1) the nerve fibers that go to make up the splanchnic nerve and (2) by producing pressure on the blood- and lymph-vessels that supply and drain the nerve cells in the spinal cord that give rise to the impulses that pass out over the roots that form the splanchnics. The first effect of a lesion on the small intestine seems to be one of vaso-motor inhibition this producing congestion. This is followed by relaxation, from the mal-nutrition, secretory and sensory disorders.

The diseases of the small intestine are characterized by a widening of the median furrow of the back, especially if the disorder is of several months duration. This widening is due to the atrophy of the spinal muscles innervated by the same segment of the cord that supplies the affected viscus, in this case the seventh to the tenth thoracic. Lesions of the lower ribs are responsible in many ways for disturbances of the functions of the small intestines. The explanation is that they affect the gangliated cord, the splanchnic nerves, the peritoneum and the muscles that form the abdominal wall. In downward displacements of them, enteroptosis is the inevitable result. The anatomical derangement in typhoid fever that is prominent, is enteroptosis, which causes a slowing of the blood stream in the intestines, this causing stagnation and lessening of the intestinal movements, all of which may be the direct result of spinal lesions affecting the innervation as explained above. In intestinal indigestion, the principal anatomical change is that of position and poor circulation through the intestinal walls. Nearly if not

all, the intestinal disorders are primarily due to disturbances of circulation that at first are characterized by congestion.

THE LARGE INTESTINE.

The **large intestine** begins at the ileo-cecal junction on the right side, is about five feet in length and comprises the following parts: the cecum, ascending colon, transverse colon, descending colon, the sigmoid flexure and the rectum.

The **cecum** is the blind commencement of the large intestine and lies in the right iliac fossa slightly below McBurney's point. It is the largest part of the intestine and has as an outgrowth from it, a worm-like process called, the **vermiform appendix.** The opening to the appendix is guarded by the ileo-cecal valve which imperfectly closes it. The cecum is generally covered with peritoneum which in part accounts for the rapidity of development of peritonitis from inflammation of the cecum and appendix. It rests on the right psoas muscle and the veriform appendix. The abdominal wall is anterior, this making palpation of it quite easy. The outer part of Poupart's ligament is in relation externally while internally, the ileum is in relation.

Impaction of the cecum is its most frequent and perhaps most important affection. This causes descent from sheer weight, pressure on the adjacent blood-vessels and the walls of the cecum and appendix and relaxation and stretching of the ileo-cecal valve. The effects of all these are weakness of the cecum and appendix and the accumulation of material in the appendix which, on account of its retention, undergoes changes that produce inflammation. **Constipation,** therefore, **is responsible for nearly all cases of appendicitis.** Descent of the cecum causes impaction of the pelvis and consequently disorders of the pelvic viscera result, leucorrhea being very common.

The **vermiform appendix** usually springs from the inner and back side of the cecum. Its direction and length vary considerably. It is supposed to be functionless and the degenerated remains of the herbiverous cecum which is quite large. By others, the vermiform appendix is regarded as the **center for peristalsis of the intestines** that is, the movements start at the appendix. In a normal condition, it has a peristalsis of its own and is capable of expelling foreign bodies that may become lodged in it. In a diseased condition of it, these bodies remain in the appendix so long that irritation and decomposition result and appendicitis follows. It has a mesentery and is completely covered with peritoneum. The principal external **landmark** for locating the appendix

is **McBurney's point,** which is "a point midway between the anterior superior spine of the ilium and the umbilicus." Tenderness and pain at this place are supposed to be quite diagnostic of appendicitis but may occur in affections of the small intestine and cecum, the Fallopian tube, broad ligament and right ovary. Lesions of the lower ribs on the right side produce pain in the region of the appendix which simulates, and is mistaken for, true appendicitis. The reason for this is that the nerves in relation with the eleventh rib, supply sensation to the integument over the appendix. A lesion of this or the tenth, affects this nerve, hence the pain in the abdominal wall at this point.

Lesions of the spinal column in this region affect the innervation of the large bowel, and in this way, produce constipation which in turn is very likely to terminate in congestion and perhaps inflammation of the appendix. On account of the proximity of the peritoneum and the intestines, suppuration of the appendix produces inflammation of these structures and peritonitis follows. Clinically, lesions of the lower ribs and lower thoracic vertebræ are associated with nearly all cases of appendicitis. The explanation is that such lesions affect the innervation not only of the appendix, but of the cecum, thereby causing stagnation of the blood, or at least the circulation through the parts is impaired.

Vaso-motor, and **trophic** impulses seem to pass from the lower part of the thoracic spinal cord to the appendix by way of the splanchnics and especially the small splanchinc nerve. These lesions interfere with this connection and thus the function of the appendix is perverted.

The appendix and the cecum are supplied with blood by the **ileocecal artery** which is a branch of the superior mesenteric. This artery divides into three branches, the anterior and posterior cecal and the artery of the appendix. They pass along the mesentery and are subject to disturbances in displacement of the bowel as in enteroptosis, a forerunner of constipation and appendicitis. The artery to the appendix passes down behind the cecum so that the accumulation of fecal masses in the ileum and cecum, produces pressure on this artery sufficient to give rise to morbid conditions of the part supplied by it. The venous blood passes into the corresponding veins that empty into the superior mesenteric and finally into the portal system. These vessels are innervated by the superior mesenteric plexus that surrounds them, the impulses being carried to the plexus by the splanchnics.

The **ascending colon** begins at the level of the ileo-cecal junction

and runs upward and a little backward to the under surface of the liver and there bends to the left thus forming the **hepatic flexure.** It is somewhat larger than the parts of the colon distal to it, the large intestine becoming smaller as it approaches the rectum. It lies almost wholly in the right lumbar region and "it often has the appearance of being pushed into a space which is too short to accommodate it." (Cunningham). The ascending colon is in relation with the anterior abdominal wall, coils of the small intestine, right psoas muscle, and is attached by areolar tissue to the iliacus and quadratus lumborum muscles and to the right kidney. It passes under the lower ribs on the right and is **further back** than it is generally supposed to be. The angle formed at the junction of the ascending and transverse colon, is in relation with the liver and this part is called the hepatic flexure. The bend is usually an acute one and if the transverse colon is sagged in the middle, the angle is all the more acute. This may give rise to disorders such as impaction or at least constipation in the part of the bowel beyond. In palpating the hepatic colon, the patient should be placed on the left side and the bowel grasped bimanually, one hand being placed behind and the other in front.

The **transverse colon** runs obliquely across the abdomen from right to left. It begins at the end of the hepatic flexure and terminates with the splenic flexure. In the first part of its course, it is attached to the duodenum and head of the pancreas by means of areolar tissue and a short mesentery. In the middle portion the mesentery is long, permitting the bowel to sag, while at the splenic end the mesentery is short and draws the colon up and back. The two ends lie in the right and left hypochondriac regions and the middle portion in the umbilical or even in the hypogastric region. The relations of the transverse colon vary because of the fact that the position of it varies. It lies behind the great omentum, which seems to protect it; is in relation with the liver and gall-bladder, stomach, pancreas, spleen, small intestines and the posterior abdominal wall. The omentum often gets rolled up and thus exposes the colon. When distended with gas, the transverse colon occupies a large part of the upper abdominal region and occasionally rises in front of the stomach. This form of displacement is infrequent as compared with prolapsus of it. When the transverse colon is really too long for the abdominal cavity or when it is apparently too long, it sags in the middle. Tight lacing is the common cause of an apparent

lengthening of the colon, since the **two ends are approximated.** If the approximation is very marked, the transverse colon is doubled down and impaction or enteroptosis is the result. As a rule the hepatic and splenic flexures retain to a degree, their normal position and thus the angle formed with the transverse colon becomes more acute, this causing impaction, obstruction or even intussusception of the bowel. In accumula-

FIG. 158.—Showing the relation of the colon to the body-wall. VIII, IX, X, XI, XII, indicate the lower ribs. The dotted lines show the boundaries of the liver and pleura.

tion of gas in the transverse colon, the bowel becomes very much distended and the percussion note tympanitic, thus interfering with the outlining of the liver and stomach. The middle portion usually lies immediately below the stomach and crosses the spinal column slightly above the umbilicus. The **splenic flexure** runs upward and backward

to the left to the lower part of the spleen. It then makes quite a sharp bend forward and downward, terminating in the descending colon. It is considerably farther back than it is generally supposed to be and on this account, impactions of it may be mistaken for tumors or displacement of the left kidney and spleen. It is attached to the diaphragm by the phreno-colic ligament which serves to anchor it. Traction exerted on this ligament as in impaction of this part of the bowel, will affect the function of the diaphragm.

The **descending colon** extends from the spleen downward to the sigmoid flexure. It is smaller and more freely movable than the ascending colon, and lies in the left hypochondriac and lumbar regions. It is covered in front and on the sides by peritoneum and usually has a mesocolon that attaches it to the posterior abdominal wall. It is in relation with the left kidney, diaphragm, psoas and quadratus lumborum muscles, and the coils of the small intestine. It is subject to distension from impaction but in many cases it becomes contracted and lessened in size. In a great many dissections made and seen by the writer, it was found that in the aged and in those that had suffered with some form of disorder of the lower bowel that the descending and sigmoid colon were uniformly small and in many cases less than an inch in diameter. The indications of a small lower bowel are constipation, toxemia, indigestion and chronic pain in the region of the lower bowel. On palpation, the cord-like body can, in favorable cases be distinctly outlined.

The **sigmoid flexure** extends from the outer border of the left psoas, to the left sacro-iliac synchondrosis where it becomes continuous with the rectum. It is of special interest in that it is so frequently displaced, impacted and abnormally bent on itself. Its displacement is most commonly due to impaction, the weight carrying the bowel lower in the abdominal cavity. From this develops prolapsus of the rectum, internal hemorrhoids and sometimes rectal ulcers. The explanation is that the displacement obstructs the return of the venous blood from the rectum and consequently distension of the veins or even ulceration follows if the stagnation is very marked or of long standing. The function of the left broad ligament and of the left ovary is disturbed as well as that of the uterus. The bend in the sigmoid becomes acute, the obstruction will in many cases result in constipation. In such cases the patient should be placed on the side or in the knee-chest posture and gentle traction exerted on the bowel through the abdominal wall, thus drawing it from out the true pelvis and straightening the angle formed.

The **rectum** comprises the remainder of the large intestine, that is, the part from the third sacral down. The large bowel enters the true pelvis at the left sacro-iliac synchondrosis and passes obliquely backward and downward in a zig-zag manner until it reaches the anus. It is in posterior relation with the uterus in the female and with the prostate gland and vesicle seminales in the male. It passes between the sacro-uterine ligaments and on account of its proximity to the pelvic organs,

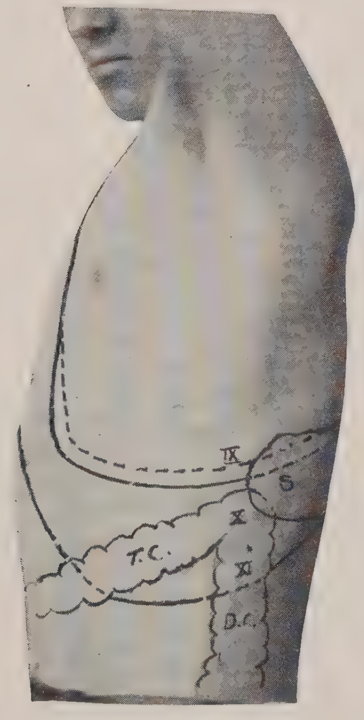

Fig. 159.—Showing the splenic flexure of the colon and its relation to the body wall, and the spleen. S. spleen; T. C. transverse colon; D. C. descending colon; the angle at the splenic flexure often becomes very acute from prolapsus of the transverse colon. The obstruction thus formed often leads to bowel disorder such as constipation.

disease of it tends to affect the function of the internal genitalia. The rectum proper is about five or six inches in length. The upper part is partly covered with peritoneum by the part reflected from the vagina

in the female and the bladder in the male. The lower portion has no peritoneal investment. This permits of great distension without peritoneal restrictions. In the female the **Pouch of Douglas** forms the lowest portion of the peritoneum and consists of the reflection of the peritoneum from the vagina to the bowel. The diameter of the upper part of the rectum is small but the lower part has a special enlargement known as the **rectal ampulla.** The function of the rectum is that of furnishing a reservoir for the accumulation of the fecal matter just before the act of defecation. Judging from the results of examination of several hundred patients, the rectum in the normal patient is empty except at a time immediately prior to defecation, in other words, if the rectum is found to be distended, it is indicative of constipation.

The **muscular coat** of the rectum is thicker than that of the bowel above, and the fibers are collected into bundles, thus giving rise to sacculations. The mucous membrane is redder, thicker and more vascular than that of the colon and is arranged in folds. These folds have received the name of **Houston's folds** or the valves of the rectum. These mucous folds often get prolapsed, this producing constipation and interfering with the introduction of a tube into the bowel.

The **anus** is the terminal portion of the alimentary canal. It is about an inch in length and is directed downward and backward. It is surrounded by the sphincters and is in relation with the perineal body, the ano-coccygeal body, and the bulb of the corpus spongiosum in the male.

The **walls** of the large intestine are composed of four coats: the serous, muscular, submucous and mucous. The serous coat is formed from the peritoneum and is fairly complete. The appendices epiploicæ, are formed from this covering and consist of small appendages or pouches of peritoneum that contain fat.

The muscular coat is arranged in layers, the **longitudinal** and **circular.** The **longitudinal** layer is so arranged that it produces a sacculation of the gut. There are three of these longitudinal bands that begin at the cecum and terminate in the rectum. The posterior of these bands is placed along the attached portion of the intestine; the anterior corresponds to the attachment of the great omentum while the third called the inner or inferior, is found on the inner border of the ascending and along the lower part of the transverse colon. When these bands are severed, the gut assumes a cylindrical shape, the sacculi become effaced and the length increased. These sacculi assist in peristalsis, ab-

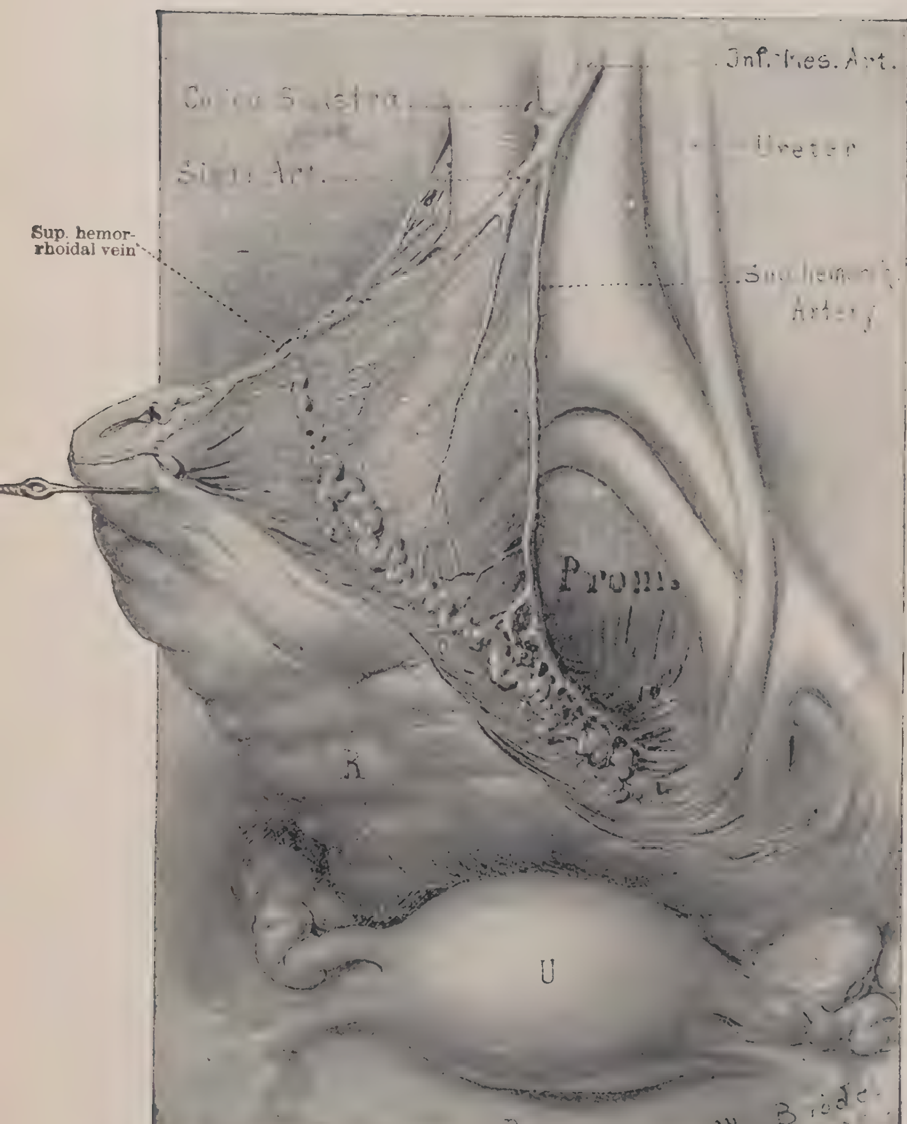

FIG. 160.—The blood supply of the lower sigmoid and rectum. (Kelly).

sorption and in giving form to the stool. In cases of constipation due to lack of peristalsis or secretion, the stool is in the form of lumps that correspond to these sacculi. The **circular muscular** fibers form a thin layer over the surface of the cecum and colon, being most marked between the sacculi. In the rectum these fibers form a thick and powerful muscular layer. The **submucous layer** consists of areolar tissue through which the nerves and blood-vessels to the bowel pass. The mucous coat differs from that of the small intestine by the absense of villi and the valvulæ conniventes. The surface is marked by numerous tubular openings called the crypts of Lieberkuhn, which resemble those of the small intestine.

The **arterial supply** of the large intestine is derived from the **superior** and **inferior mesenteric** arteries and from branches of the **internal iliac** that supply the rectum. The size of the mesenteric arteries is controlled by the mesenteric plexuses which ultimately derive their impulses from the lower thoracic and upper lumbar segments of the spinal cord. The rectum is supplied with arteries that are derived from three sources, viz., the superior hemorrhoidal from the inferior mesenteric, the middle hemorrhoidal from the internal iliac and the inferior hemorrhoidal from the pudic. These vessels anastomose freely with each other by means of the branches of the loops formed by them. Experimentally, it has been ascertained that stimulation of the anterior roots of the lower thoracic and upper lumbar nerves produces vaso-motor changes in the colon. Lesions of the corresponding vertebræ either stimulate or inhibit these vaso-motor nerves and consequently a dilating or a constricting effect results from the lesion. Ordinarily the lesion produces a dilatation of the blood-vessels of the bowel by exerting an inhibitory effect on the vaso-motor nerves in relation.

The blood from the colon passes up through the superior and inferior mesenteric veins and ultimately through the portal system. This is of importance, since on this account, liver disorders will cause intestinal disturbances. If the liver becomes congested, the blood with difficulty passes through it and since all the blood of the intestinal tract with the exception of a part of the rectum passes into the portal vein, consequently congestion of the bowel is the sequel. Congestion of some part of the body is at the bottom of practically all diseases, and reasoning from this, the importance of the hepatic circulation being kept in good condition can not be emphasized too much. The blood from the

upper part of the rectum passes into the superior hemorrhoidal veins which empty into the inferior mesenteric. This explains the relation of liver disorders to hemorrhoids. There is a communication between the portal and systemic circulation through the hemorrhoidal plexus, some of the blood returning by way of the portal and some by way of the internal iliac veins. All the veins of the large bowel undoubtedly have vaso-motor nerves that control their calibre but they are not so numerous as the vaso-motor nerves of the arteries for the reason that there are not so many muscle fibers in their walls. Lesions of the spinal column affect the veins as well as the arteries and the effects are even more extensive and important than are those on the arteries.

The **nerve supply** of the large intestine is derived from the superior and inferior mesenteric plexuses, the hypogastric by way of the hemorrhoidal from the pelvic pelxus, and from the sacral nerves that pass into the pelvic. The **segments** of the spinal cord that give rise to most of the impulses that supply the large bowel are the lower two or three thoracic and the upper lumbar, while the second and third sacral supply the rectum and anus. In speaking of the cerebro-spinal innervation of the rectum and anal canal Quain says: "Experiments on animals have shown that the longitudinal muscular fibers of the rectum are supplied with motor fibers from the anterior roots of certain of the sacral nerves, (2nd and 3rd, and in part the 1st, in the dog), which nerves also supply inhibitory fibers to the circular coat, whereas the fibers of the hypogastric plexus which supply the circular muscular tissues with motor fibers, are derived from white rami communicantes of the anterior roots of certain of the lumbar nerves, which join the sympathetic chain and lose their medullary sheath before passing to their distribution in the muscular coat."* According to Langley the rectum has a double nerve supply, an upper supply in the rabbit from the second, third, fourth and fifth lumbar nerves and a lower from the third and fourth sacral nerves. "The upper set of fibers pass into the lumbar sympathetic chain, and thence in the mesentery to the inferior mesenteric ganglia, and so by the colonic and hypogastric nerves to the rectum. They are connected with nerve cells chiefly in the inferior mesenteric ganglia, and supply the descending colon, rectum, and internal sphincter. A few fibers pass along the sympathetic chain to the sacral ganglia, and thence by the grey rami of the ganglia to the sacral nerves, and end chiefly in the unstriated muscles of the skin round the anus. The lower set of

*Quain's Anatomy, Vol. III, p 117, pt. IV.

fibers run in the pelvic nerves, or nervi erigentes. They pass to the hypogastric plexus and have ganglion cells either as they pass the side of the rectum or more peripherally."* This form of distribution of these nerves seems to also be true in the human judging from the effects of lesions in the lumbar region. These lumbar lesions affect the innervation of the large bowel because the nerve impulses pass through the lumbar intervertebral foramina which are lessened in size in lesions of the articulations. This breaks, or otherwise affects the connection that should exist between the spinal center and the gut and consequently the function of the part innervated is affected.

The large bowel furnishes a reservoir for the food products in which there is desiccation, absorption and some digestion. The peristalsis of this part of the bowel is less than that of the small intestines, it taking about twelve hours for the matter to pass through the large intestine. The longer the time consumed in the passage, the drier will be the contents. The drier the contents the less the irritability, and constipation is the result. If the peristalsis is so increased that the contents of the small intestine are carried down rapidly into the large, diarrhea is the effect. The secreting of mucus, called the **succus entericus,** is also an important function of the large bowel. This secretion acts as a stimulus to the sensory nerves supplying the part, that is, peristalsis is dependent to a great extent on the amount of this secretion in the bowel. If there is an excessive amount secreted as is the case in colds that "settle" on the bowels, diarrhea usually follows. If the secretion is lessened in amount, constipation is the effect. Lesions of the lumbar vertebræ affect all the functions of the large intestine by disturbing the nerves that control peristalsis, secretion, absorption, sensation and nutrition and by affecting the circulation of the lymph and blood through it. The principal effects of these disturbances are constipation, diarrhea, indigestion, prolapsus of the bowel, hemorrhoids and ulcers.

The character of the stool and defecation is the principal guide as to the amount and character of disturbance of the bowel. In the diagnostic indications of the feces, the quantity and quality of the food ingested must be taken into consideration as well as the kind of disturbance of the bowel. Blood in the stool is suggestive of hemorrhoids or fissure of the rectum. A ribbon-shaped stool is found in stricture of the

*Schafer's Physiology, Vol. II, p. 337.

rectum. If dry and nodular, it indicates lack of secretion and slow peristalsis. If watery and slimy, congestion or catarrh of the bowel is usually present. If the stool is tinged with green, it is indicative of either liver disorder as in colds, or of marked inflammation of the bowel as in cholera infantum. The above changes in the character of the stool are mostly dependent on disorders of the large intestine. The character and frequency of defecation are also indicative of the kind and degree of the disturbance of the lower bowel. In some cases there is lack of force or strength while in others there is tenesmus, an inhibitory lesion producing the former and an irritative one, the latter. Practically all of these disturbances of the lower bowel are primarily the result of lesions along the spine that affect the motor, sensory, vaso-motor, secretory and trophic nerves supplying the bowel, while the error in diet and other exciting causes, the more easily and readily act on account of the predisposition. For a palliative effect, inhibition applied over the spinous processes of the third or fourth lumbar spines will ordinarily check diarrhea. Colic, tenesmus and other acute sensory and motor disturbances can be temporarily relieved in a similar way. In flux and dysentery, the blood-vessels are engorged to the bursting point, this being the result of vaso-motor disorders. A subluxation of the fourth lumbar vertebra is the most common and frequent of all lesions producing these effects. The explanation as pointed out above, is that the vaso-motor impulses for the lower bowel rise principally from the fourth lumbar segment and pass out through the fourth lumbar intervertebral foramina and the lesion of this vertebra lessens the size of the corresponding foramina and consequently the impulses passing through them are affected.

THE KIDNEYS,

The **kidneys** are two bean-shaped bodies situated in the lumbar regions. They are behind the peritoneum and consist of a duct, the ureter, leading from the sinus located in the hilum, uriniferous tubules and a glandular substance. The kidney is about four and three-quarters inches in length and slightly over an inch in thickness, and weighs on an average of five ounces. It is surrounded by a mass of adipose tissue that protects it and assists in holding it in position. The right is the lower of the two on account of the presence of the liver on that side pressing it downward. The left kidney in the male reaches from the eleventh

thoracic vertebra to the upper border of the third lumbar. Both kidneys are **lower in the female**, about the distance of half the body of a vertebra. They lie obliquely with their lower parts diverging.

The **position** and consequently the relations of the kidney, are subject to great variations. Cunningham states that if a line is drawn round the body at the level of the lowest part of the thoracic wall, the whole or almost the whole of the left kidney, will be found to lie above the level of the plane so determined, and that by far the greatest part of each kidney lies to the inner side of a line drawn vertically upward through the middle point of Poupart's ligament. There are no ligaments for the purpose of holding the kidney in position, but its fixation depends on the pressure of the surrounding tissues.

Posteriorly, the kidney is in relation with the psoas, quadratus lumborum, diaphragm and transversalis abdominis muscles; pleura; the last thoracic and the first lumbar nerves and the fascia in that region. On account of the relation between the kidney and the pleura, a circumrenal abscess may invade the pleura and the lung. The diagnosis of pleurisy with effusion may be confused with perinephritic disorders. In operations on the kidney, this relation to the pleura should be borne in mind or else the pleura may be injured. **Superiorly,** it is in relation with the suprarenal capsule that crowns the kidney. **Anteriorly,** the relations of the two kidneys differ slightly. The anterior surface of the right, is in relation with the liver, ascending colon and the duodenum, second portion. The part in relation with the liver is covered with peritoneum. The **anterior** relations of the left kidney are the stomach, pancreas, descending colon, spleen and the vessels of the spleen and colon. It is attached to the suprarenal capsule and the pancreas by areolar tissue but is separated from the stomach by the lesser sac of the peritoneum. From in front the external landmarks of the kidney are the umbilicus and the spines of the iliac bones and the lower ribs. The lower pole of the kidney extends somewhat below the subcostal plane with the hilum lying about one and one-half inches from the median line and opposite the first lumbar vertebra. "In order to place the finger over the kidney from in front, a point on the abdominal wall should be chosen about two and one-half inches above and outside of the umbilicus." (Moorhead). Posteriorly the outline of the inner border of the kidney may be represented by a "line drawn parallel to the mesial plane at a distance of inch from it and lying between the levels of the

superior and inferior poles. The hilum of each kidney lies on, or external to, this line, at the level of the first lumbar spine."

As stated before the kidney is supported principally by the pressure of the surrounding structures. If the pressure from above is increased and that from below lessened, the kidney will assume a position lower in the abdominal cavity. The pressure is increased from above in the female, principally by tight lacing, while that from below is lessened by the relaxation that usually follows pregnancy. It is the exception for prolapsus of the kidney to occur in patients that have not given birth to a child. Most cases occur in patients that have given birth to two or more children, or at least if there is much relaxation from faulty involution of the abdominal walls or from other causes. Lesions of the lower ribs or of the spine that produce relaxation of the abdominal muscles or enteroptosis, will tend to bring on prolapsus of the kidney or what is called a floating kidney.

The **blood-supply** of the kidney is very copious, and is derived from the **renal,** a branch of the abdominal aorta. It enters the hilum of the kidney and immediately breaks up into several large branches which penetrate the substance of the gland and pass to the cortex. "At the base of the pyramids branches of the arteries form an anastomosing plexus. From this plexus vessels are given off, some of which follow the straight tubules toward the apex of the pyramids, vasa recta, while others enter the cortex and pass to its surface. In the course of the latter, small branches are given off, each of which soon divides and subdivides to form a ball of capillary vessels known as the glomerulus. These capillaries, however, do not anastomose, but soon reunite to form an efferent vessel the caliber of which is less than that of the afferent artery. In consequence of this, there is a greater resistance to the outflow of blood than to the inflow, and therefore a higher blood-pressure in the glomerulus than in capillaries generally."* The **innervation** of the renal vessels is derived from the lower thoracic segments of the spinal cord the impulses passing from them by way of the lower splanchnics into the aortic and renal plexuses. "The vaso-motor nerves of the kidney leave the cord from the sixth dorsal to the second lumbar nerve. In the dog, most of the renal vaso-motor fibers are found in the eleventh, twelfth and thirteenth dorsal nerves. Stimulation of the nerves entering the hilus of the kidney between the artery and the vein, causes a

*Brubaker's Physiology, p. 427.

marked and sudden renal contraction but the organ soon regains its former volume."* In man, the vaso-motor centers of the kidney seem to correspond to those of the dog as cited above. Lesions of the corresponding vertebræ and ribs either stimulate these nerves or else they inhibit them. In both cases there will be a pathological effect if continued for any length of time. Experimentally, it has been proven that stimulation of certain of the roots of the spinal nerves produces circulatory changes in the kidney and clinically it has been demonstrated that a lesion of the vertebral articulations in relation, will have a similar effect. The explanation is that the vaso-motor impulses pass over these spinal nerves through the intervertebral foramina and these are lessened in size by the lesions. The blood supply of the nerves themselves is also affected by the lesion by impinging on the vessels that supply them. These lower thoracic lesions so weaken the kidney by affecting the vaso-motor nerves to them that they are predisposed to almost any sort of disorder.

The **veins** correspond to the arteries, collect the blood from the capillaries and unite to form radicles across the pyramids which finally reach the sinus and form the tributaries of the renal. The blood in the renal veins is perhaps more nearly pure than that found in other veins on account of the action of the kidney on it. These veins seem to have vaso-motor nerves as do most other veins but this as yet has not been demonstrated satisfactorily.

The **nerves** supplying the kidney come from the renal plexus. This plexus is formed by filaments from the lesser and least splanchnics, the aortico-renal ganglion, the aortic plexus and a branch from the first lumbar ganglion. The filaments accompany the arteries to the kidney. "Non-medullated fibers penetrate to the surface of the capsule and between the urinary tubules. It is established physiologically that motor fibers are present for the unstriated muscular fibers, also vaso-motor fibers and sensory branches in the capsule and the pelvis of the kidney. The existence of vasodilator and secretory fibers is also probable."† Head in his chart of visceral sensation states that the sensory supply of the kidney and ureter is from the tenth, eleventh, twelfth thoracic and the first lumbar. This corresponds to the clinical observations, since in affections of the kidney, lesions are found in this region.

*Am. Text-book of Physiology, p. 498.
†Landois' Physiology, p. 471.

Since the centers for the kidney are undoubtedly located in the lower thoracic segments of the spinal cord and the impulses pass out through the foramina over the splanchnic and upper lumbar nerves, lesions of the corresponding vertebræ (from the tenth thoracic to the second lumbar, the twelfth being the most important) will affect the function of the kidney through the innervation of it.

The **function** of the kidney is that of excretion of the urinary constituents from the blood. Bowan, who was one of the first to investigate the process of elimination of the urine from the blood, inferred that since the kidney presented an apparatus for filtration, the capsule with its inclosed glomerulus, and an apparatus for secretion, the epithelium of the uriniferous tubules, the elimination of the urinary constituents from the blood was accomplished by two processes, that of filtration and of secretion. This is the most generally accepted of the theories at the present time. There are three things to be taken in consideration in determining the amount of secretion of urine: the **blood-pressure,** the **quality** of the blood and the influence of the **nervous system.** If the blood-pressure in the vessels of the kidneys is increased, the amount of urine secreted is increased. It has been found that ligation of the carotid, femoral and vertebral arteries increased the aortic pressure accompanied by an increased urinary flow. On the contrary a decrease of aortic pressure was accompanied by a lessening of the secretion and if the pressure were lowered below 40 mm. of mercury, the flow of urine ceased entirely. Lesions along the lower thoracic areas affect the vaso-motor supply of the renal vessels and consequently increase or decrease the blood-pressure in them. From this arises disturbances in the amount and quality of the urine excreted. The amount of urine secreted is also affected by changes in the composition of the blood. The presence of **urea** in the blood acts as a diuretic. An excess of water ingested has a similar effect. Saline diuretics when introduced into the blood increase the amount of urine. The accumulations of end-products and water in the blood, act as stimulants to the kidneys and thereby increase the amount of urine. Lack of elimination of the skin causes an increased activity of the kidneys as is illustrated in certain diseases and by the fact that the amount of urine excreted is a great deal less in patients that prespire freely than in those that do not. Lesions that affect the liver, produce urinary disorders by interfering with the secretion of urea which is nature's diuretic. That the nervous system exerts a marked

influence over the secretion of urine is proven by experiments in which the nerves are severed or stimulated. If the nerves that accompany the renal vessels to the kidney are divided, the artery at once dilates, the kidney enlarges, and the amount of urine secreted is at once increased. If the peripheral ends of these nerves are stimulated, the blood-vessels become smaller, the volume of the kidney decreases and the flow of urine becomes lessened or stops entirely.

There is a direct connection between the **spinal cord** and the **kidney** and if the nerves making this connection are stimulated or inhibited, or if the **cells** in the spinal cord that give rise to the impulses passing over these nerves are stimulated or inhibited, there will be an immediate effect on the kidney manifest by **change in the urine.** Lesions of the spine, especially of the tenth, eleventh and twelfth thoracic vertebræ, affect the above nerves and their cells, and are the predisposing causes of disease of the kidney.

There seems to be a **vaso-motor center** for the kidney situated in the **medulla oblongata**, since puncture of the medulla is occasionally followed by an increase in amount of urine. Cases of **diabetes insipidus** have been reported me in which the lesion was in the upper part of the cervical region, and the cases cured by correcting the lesion.

Disturbances of function of the kidney result from **nutritional changes** in the substance of the organ. Spinal lesions are usually the primary causes, but **abuse of the kidney,** is a very important cause of organic disease and should be considered along with the spinal lesions. The motor, secretory, trophic, vaso-motor and sensory innervation of the kidney is derived from the spinal cord, the impulses passing to the kidney by way of the anterior nerve roots, common trunk, anterior division, white rami, lesser and least splanchnics, aortico-renal ganglion, aortic plexus and renal plexus. Lesions along the lower part of the spine affect the generating or transmission of these impulses and consequently, some or all of these nerves are affected. The most important are the vaso-motor nerves, since secretion, circulation and nutrition seem to depend on their integrity.

In all affections of the kidney the urine should be thoroughly examined. The urinary changes that are suggestive of disease of the kidney are, lessened or increased **amount;** change in the **color** varying from the limpid urine to hematuria; and changes in the **constituents,** there being present albumen, blood, pus, urates, phosphates, casts, sugar, and an absence of urea.

If the **amount** of urine is permanently increased, it is indicative of some form of diabetes, the specific gravity test and character of the solids, making the diagnosis clear. A lessening in the amount of urine secreted, is suggestive of a contracted or non-developed kidney. The writer has had several cases in which the kidney was imperfectly developed, the patient having a pasty complexion, general weakness, headaches and backache due to the toxemia, indigestion, constipation, and in fact, everything that has for its cause toxemia, the symptoms varying with the degree and amount of toxic matter retained in the body. In such cases I have invariably found a marked **separation** or **break** in the spine ranging from the **eighth, to the twelfth dorsal** vertebra, the articulation between the **tenth and eleventh** being most commonly affected. In some cases of scanty elimination of urine, hysteria should be considered as a factor. The condition of the nervous system also has a great deal to do with the amount as well as the quality of urine excreted. If the urine is watery in appearance, suspect diabetes insipidus or nervousness. If of a light amber color, diabetes mellitus may be present. If red, suspect blood or an excess of urates. Heating the urine will clear it up if the red color is not due to the presence of blood. Albumen in persistent quantities in the urine is almost diagnostic of organic disease of the kidney as in Bright's disease. Pus is suggestive of cystitis; phosphates, of some disturbance of the nervous system and is usually present in the pregnant. **Casts** in the urine are usually diagnostic of nephritis and should be looked on with alarm. Sugar found in quantity and from time to time, is diagnostic of diabetes mellitus. The absence of urea leads to uremic poisoning and in the pregnant will often lead to eclampsia. Liver disorder is more often to blame for the absence of urea than is kidney disturbances, since the urea is formed in the liver and this formation is affected by diseases of the organ.

In all affections of the kidneys characterized by urinary changes and practically all are, the spinal lesions are the predisposing causes and if a cure is secured, these must be corrected. In all cases it is advisable to make a test of the urine since the urine is a pretty reliable indicator of the condition of the body as well as that of the kidney itself. This examination should include the microscopic as well as the chemical test since by it, casts are discovered if they are present, spermatozoa, crystals, bacteria, and pus.

The **ureter** is the excretory tube or duct of the kidney connecting

the pelvis with the bladder. The pelvis of the kidney is really the expanded portion of the ureter, which in turn divides into three infundibula and these into the calices. The **size** of the ureter varies but on an average is about that of a goose-quill. Its length is about thirteen inches. In its course it is in relation with the psoas magnus muscle, external iliac artery, spermatic vessels and on the right with the inferior vena cava and on the left, the sigmoid flexure of the colon. They pass down behind the bladder which they enter, at the lower part or near the **trigone.** Enlargement of the uterus as in pregnancy or tumor, may cause pressure on the ureter and thus produce hydronephrosis. Contracture of the muscles in relation with it sometimes affects its function. Inflammation of the pelvic tissues occasionally reaches to the ureter.

It has three **coats,** a **fibrous,** which seems to be continuous with the capsule of the kidney, a **muscular** composed of a circular and longitudinal layers, and the **mucous** coat in which the epithelium is loose and arranged in folds.

The ureter is capable of great, though painful, distension as is demonstrated by the passing of large calculi. These calculi are most likely to lodge in the upper part because it is the largest. Care should be taken in manipulating over the ureter if a calculus is lodged in it because pressure or manipulation directly on the calculus, will increase the pain because the sharp corners of it are forced into the wall of the ureter. Gentle inhibition applied to the ureter sometimes causes relaxation and consequently dilatation so that the stone is passed the easier along the tube. The **external landmarks** of the ureter should be borne in mind on account of the treatment and the help in the differential diagnosis of calculi and colic in that part of the body.

The **arteries** supplying the ureters are derived from the renal, spermatic, internal iliac, and vesical arteries. The innervation of these arteries comes from the plexus that surrounds the arteries of which they are branches. The **veins** empty into the corresponding trunks. The **nerve** supply is derived from the spermatic, hypogastric and renal plexuses. The ureter is highly sensitive as is evidenced by the severe pain accompanying the passage of a renal calculus. On account of the number of nerves and plexuses that contribute to the innervation of the ureter, a calculus in it will cause the pain to be referred to the testicle, kidney, bladder, down the inner side of the thigh and to the abdominal wall in relation with the ureter. In the palliative treatment for renal cal-

culi, inhibition applied to the spine from the eleventh thoracic to the second lumbar vertebra will ordinarily relieve or lessen the pain or colic. Lesions in this region will affect the innervation of the kidney and ureter and produce effects that are similar in character to the passing of renal calculi. According to Head, the sensory impulses for the ureter are derived from the tenth thoracic, for the upper part, and from the first lumbar, for the lower part. Clinically, it seems that the sensory impulses reach the spinal cord through the spermatic and renal plexuses and that lesions affecting these will produce pains that will be referred to the ureter.

THE BLADDER.

The **urinary bladder** is a hollow, musculo-membranous receptacle for the urine. Its average capacity is about one pint when moderately distended but is capable of great distension especially in the female, so that it may contain a half-gallon or more. The size, position and shape of the bladder, vary with the amount of urine in it, sex and the condition of the surrounding structures. In the infant, the bladder extends above the pubic bone and on this account, in distension of it, can be manipulated and micturition be brought about in most cases of distension, without the use of a catheter. In the adult, it is entirely in the true pelvis except when markedly distended with urine. It is broader and larger in the female than in the male.

The bladder has been divided into the **summit, body, trigone** and **neck** for the sake of convenience in its description. The summit is rounded and connected with the umbilicus by the **urachus,** the obliterated intra-abdominal portion of the allantoic stalk of fetal life. In some cases this tube or stalk does not become obliterated and consequently, a connection exists between the bladder and the umbilicus and urine escapes from the latter point. The **body** comprises the greater part of the bladder and when distended is in relation with the anterior abdominal wall and all the pelvic viscera. The **trigone** is the most sensitive portion and consists of the area between the entrance of the ureters. Any irritation of this part will produce micturition and if kept up, frequent and perhaps painful micturition. The **neck** is that part which is constricted and is continuous with the urethra.

The **ligaments** of the bladder are divided into true and false-five of each—the false consisting of folds of peritoneum. The **true ligaments**

are formed principally from the fascia in relation, the recto-vesical, except the superior one which is the remains of the urachus. Some of them contain muscle fibers and consequently are subject to considerable relaxation and contraction. The **false,** are simply folds of peritoneum derived from that which covers and dips down on all sides but particularly the front and back.

In **structure** the bladder is composed mainly of unstriped muscle fibers covered with fascia and peritoneum and lined with a mucous membrane. The **walls** are quite thick ranging from an eighth to a half of an inch. The mucous membrane is continuous with that lining the ureters and urethra which thing permits inflammation to travel the easier from one part to the other, especially from the urethra to the bladder as in cystitis from urethritis.

The **relations** of the bladder are of interest in that diseases of it are most frequently secondary to disease, displacement or enlargement of structures or viscera in relation. **Anteriorly,** it is in relation with the anterior ligament, symphysis pubis, and in the female, with the anterior vaginal wall. As a result of these relations, the bladder when distended, will produce a rounded, symmetrical enlargement of the abdomen immediately above the pubis, a bulging of the anterior vaginal wall as in cystocele, and is subject to injury from operations on the symphysis as in symphysiotomy an operation resorted to by some in cases of parturition in which normal delivery is impossible on account of deformity or a lessening in size of the pelvis.

The bladder can be reached by a local vaginal examination and in calculi or prolapsus of it, the condition is better diagnosed and possibly remedied, by the local treatment. **Superiorly** and **posteriorly,** the bladder is covered with peritoneum thus permitting of the development of peritonitis from inflammatory disturbances of the organ. In the male the rectum, sigmoid flexure, and small intestines, the vesical seminales and the prostate gland are in posterior relation. Disease of the bowel or any of these organs may affect the bladder. If there is enlargement or if the disease is an irritative one, frequent micturition is a sequel as in enlargement of the prostate. In the female, the uterus is in posterior relation and in forward displacements or inflammation of the uterus, the bladder is affected, frequent and painful micturition being the most common of the effects. The explanation is that pressure on the bladder sets up impulses that are carried to the micturition center and thus

it is kept in a state of continual activity. The effect is the more marked if the uterus is inflamed and antedeviated at the same time. The hypogastric arteries, vasa deferentia, and the pelvic nerves are also in relation but this is of little practical importance except that inflammation of the bladder tends to produce disturbance of these structures.

The **blood-supply** of the bladder is derived from the **vesical** arteries, the **obturator** and **internal pudic,** and in the female, some twigs of the **uterine** and **vaginal** arteries go to the bladder. The superior and middle vesical, usually come from the obliterated hypogastric arteries and the inferior, from the anterior division of the internal iliac. The nerves innervating these arteries are derived from the lumbar segments, the impulses passing by way of the lumbar nervi efferentes through the hypogastric and pelvic plexuses into the vesical. Some probably pass by way of the sacral nerves but experimentally, little if any vaso-motor effect follows stimulation of the pelvic nerve. Although it has not been demonstrated experimentally that the vaso-motor impulses for the bladder are derived from the lumbar or even the sacral nerves, yet there are clinical evidences that most of the impulses are derived from the lumbar nerves. The principal proof is that lesions affecting the lumbar vertebræ are usually found to be present in all cases of vascular disturbances of the urinary bladder, and by correcting the lesions, beneficial effects were obtained.

The **veins** form into plexuses at the sides, base and neck of the bladder and finally empty into the internal iliac. In disorders of this vein, the venous circulation of the bladder is often quite seriously interfered with. The **lymphatic** vessels follow a similar course and in cystitis, the glands in the lumbar region are enlarged and tender. Manipulation over them is fraught with danger, irritation of them increasing the engorgement and tenderness.

The **nerve** supply of the bladder is derived from the second, third and fourth sacral nerves and from the hypogastric plexus. The impulses that pass over the sacral nerves go directly to the pelvic plexus without going through the gangliated cord. The fibers are small and medullated and are called the pelvic splanchnics. The **vesical** branches of the hypogastric plexus are non-medullated and are derived from the upper lumbar nerves. They reach the hypogastric plexus by way of the aortic plexus and the inferior mesenteric ganglion. They reach the bladder by passing through the pelvic plexus and over the vesical plexus, a subdivision of the pelvic.

The **sensory innervation** of the bladder is derived from the upper four sacral nerves and quite a "number of sensory fibers pass into the spinal cord through the intermediation of the hypogastric plexus."

Contraction of the bladder is a reflex process and like other reflex processes, there must be a stimulus, afferent pathway, center, efferent nerve and muscles that receive the impulses. The above named sensory nerves carry the impulses generated by the accumulation of urine in the bladder, to the micturition center situated in the second lumbar segment of the spinal cord, while the efferent impulses are carried by the lumbar nerves into the hypogastric and pelvic plexuses, thence to the vesical. The **sacral** branches are supposed to be motor to the longitudinal fibers and inhibitory to the circular, while the hypogastric branches have just the opposite function. The bony or spinal lesions that are important as etiological factors in the production of disease of the bladder are most frequently found in the upper lumbar region. They disturb the function of the bladder by interfering with the connection of the bladder and the spinal cord and consequently there are sensory, vaso-motor, trophic, secretory, and motor disturbances from these lesions. If the lesion is irritative, the sensibility of the bladder will be increased and frequent and painful micturition occurs, since it is a reflex process. If it is inhibitive, urine will accumulate in the bladder on account of the inhibition of the sensory and motor nerves as well as the micturition center. These lesions interfere with, or break the connections existing between the bladder and the spinal cord by lessening the size of the intervertebral foramina and by direct pressure on the nerves and on the blood-vessels supplying nutrition to the spinal centers. If the center is irritable as in **enuresis,** inhibition applied at the exit of the nerves from the intervertebral foramina, will quiet the center and temporarily relieve the condition. Stimulation will have the opposite effect. A lesion will have either, and thus to **cure the condition, correction of the lesion is imperative.** The trophic, secretory and possibly the vaso-motor impulses pass over the same nerves and are thus subject to derangement from the same lesions. Since the function of the urinary bladder is that of expelling as well as retaining the urine as it is secreted by the kidneys, the motor nerves are important but since their action seems to be under the control of the sensory, micturition being a reflex process, the latter are the most important from a clinical point of view.

THE SUPRA-RENAL CAPSULES.

The **supra-renal bodies** are two solid organs that cap each kidney. They, like the thyroid gland are ductless. The right capsule is pyramidal in shape. Its anterior surface rests on the posterior surface of the right lobe of the liver, upon which it leaves an impression. Posteriorly it is in relation with the right crus of the diaphragm while its inner aspect presents a vertical furrow that is moulded against the inferior vena cava. The left, is crescentic in shape and is in relation anteriorly with the stomach, spleen, pancreas, and the splenic vessels. Posteriorly, it rests against the crus of the diaphragm, and is near the aorta. Both are in relation with the great splanchnic nerve and the semilunar ganglion.

The **blood-vessels** supplying the suprarenal capsules are derived from suprarenal arteries and from branches of the renal and phrenic. After reaching the hilum they break up into many minute twigs before entering the substance of the organ. The **vaso-motor nerves** supplying them follow the arteries into the capsule and are derived from about the same source as those that supply the kidney, especially the tenth and eleventh thoracic segments. The impulses pass from the spinal cord to them by way of the splanchnic nerves, they containing vasodilator and secretory fibers for the suprarenal capsules. The **veins** on the right side empty into the vena cava and sometimes into the phrenic and renal by means of a number of small branches. Those on the left, empty into the renal on that side. From this it follows that diseases characterized by congestion of the renal vein, will affect the circulation of the adrenal body. The **lymphatics,** empty into the renal glands which contain a great deal of pigment.

The **nerve supply** of the suprarenal capsules is very abundant as well as the number of blood-vessels. They form a rich interlacement and are derived from the renal and solar plexuses, filaments from the splanchnics, phrenic and pneumogastric nerves. They are made up principally of fine medullated fibers and most of them have small ganglia on them before entering the organ.

The **function** of these capsules is practically unknown. After extirpation of one gland, the other doubles in size while removal of both is followed by death with symptoms of poisoning. If only a small part is left in, these symptoms are absent. "It appears, therefore, that the suprarenal bodies are also designed to destroy a poisonous substance in

the body, which exhibits its injurious effects after extirpation of the glands."* He further states that Brown-Sequard believed that one of the functions of the suprarenal bodies is to inhibit excessive pigment formation. In agreement with this view, Tizzoni found, after extirpation of the organs (in rabbits), abnormal pigmentations, especially on the lips, and Boinet in the blood and subcutaneous cellular tissues (of rats). In the medullary layer a substance is formed that becomes brown when exposed to the air or brought in contact with alkaline tissues. In man, the skin often presents a bronzed pigmentation (bronzed skin, Addison's disease) when the suprarenal bodies and their capsules have undergone (tuberculous) degeneration. From experiments it is to be concluded that the suprarenal body has an **internal secretion** that has to do with the elaboration of the blood and which stimulates the muscle fibers of the heart and arteries. That its function is an important one is indicated by the great number of nerves and blood-vessels that supply it. Clinically, we have not had enough cases in which it was positively known that the gland was affected, to draw any definite conclusions as to the effects of a lesion on its function, but judging from the source and course of the nerves and vessels that supply it, lesions of the lower thoracic vertebræ and ribs will undoubtedly affect its function.

THE OVARIES.

The **ovaries** are two almond-shaped bodies, varying in size in different people and at different times in the same individual, which are attached to the posterior layer of the broad ligaments, uterus and pelvic wall. They are about one and one-half inches in length, about three quarters of an inch in width and one-half an inch in thickness, and are located within an inch to an inch and a half of the uterus. The application of this fact is, that uterine displacements are accompanied by displacement of the ovaries, a condition quite common. The ovaries are regarded as the most important of the pelvic viscera, since without them there would be no menstruation, absence, or imperfect development of the uterus and mammary glands, and the function of the internal generative organs would be lost.

They are held in position by the **broad,** the **infundibulo-pelvic** and **ovarian** ligaments which attach them to the uterus and pelvic wall. The **infundibulo-pelvic** ligament is that part of the upper portion of the

*Landois' Physiology, p. 198.

broad ligament that is in relation with the Fallopian tubes and attaches the ovary to the innominate bone. The **ovarian,** is a longitudinal fold of peritoneum attaching the ovary to the uterus, into which unstriped muscle fibers are prolonged from the uterus. Relaxation of the uterine muscle fibers would be accompanied or followed by relaxation of this ligament and this by displacement of the ovary, prolapsus being the most frequent form of displacement. During fetal life, the ovaries are in the abdominal cavity, descent not being complete until the tenth year. They remain small until puberty at which time they become enlarged and assume activity.

The external **landmarks** are the anterior superior spines of the ilia, the ovaries being located about two inches internal and one and one-half inches inferior to this spine. The **size** varies with the age of the individual, and according to the state of sexual activity. After cessation of the sexual function the ovaries atrophy, diminishing in size from one-half to one-third. In old women they are often as small as peas, the atrophy being gradual after the menopause.

They consist of two parts, the **stroma** or frame-work and the **parenchyma.** They are covered by columnar epithelium, sometimes called **germinal epithelium.** Immediately beneath this epithelial layer, is the **tunica albuginea** which is composed of fibrous tissue which contains a few muscle fibers. The **Graafian** follicles, in all stages of development, are imbedded in the connective tissue or stroma and contain the ova. The younger and smaller lie in the cortical area. Their number is immense, it being estimated from 40,000 to 70,000. During menstruation, one or more of these follicles ruptures, permitting the ovum to escape. After rupture, the ovum is caught by the fimbriated extremity of the tube, carried or drawn into the tube and transmitted to the uterus, partly by the action of the ciliæ and partly by the peristaltic action of the tube. In young women, the surface of the ovary is smooth and glistening in appearance, but as the woman continues to menstruate, and the Graafian follicles rupture, it begins to appear scarred and corrugated; in the aged it resembling the convolutions of the brain. In diseased conditions, such as inflammation and congestion, there is some interference with the rupture of the Graafian follicle and the ovarian form of dysmenorrhea results. This form is best diagnosed by the time of the appearance of the pain in reference to the beginning of the flow, it preceding the flow from four to six days. As soon as the follicle ruptures, it is filled

with a yellowish fluid which is gradually absorbed, leaving a scar which is called a **corpus luteum.** If impregnation does not follow the rupture of the follicle, it is called a **false corpus luteum,** but if impregnation does take place, it is called a **true corpus luteum** and is not readily obliterated.

The **function** of the ovary is that of maturing and expelling the ovum and of regulating menstruation, therefore, any disturbance of the function of the ovary will result in sterility or menstrual disturbances. The ovary is supposed to have an internal secretion that has to do with the elaboration of the blood. "From the time that Brown-Sequard published his studies upon the secretion of the testicles, it has been more or less generally believed that the ovaries likewise elaborate a somewhat analogous product, which plays an important part in the female economy. Indeed, Knauer's recent work renders it probable that this secretion is directly concerned in maintaining the integrity of the other generative organs; inasmuch as he has shown that atrophy of the uterus and vagina rapidly follows the removal of the ovaries, whereas this does not occur when the ovaries are removed from their normal position and transplanted to other portions of the body. Knauer therefore concludes that in such cases the absence of atrophy must be attributed to the action of the internal secretion of the transplanted ovaries, since all nerve connections were severed at the time of operation."*

The **blood-supply,** comes from branches of the ovarian artery, some six or eight in number, which enter the ovary at the hilum. The **veins** correspond to the arteries and enter the pampiniform plexus in the broad ligament, from which the blood is carried by the ovarian veins to the renal on the left side, and to the inferior vena cava on the right. On account of the presence of the rectum on the left side, constipation being so common, and the left ovarian vein entering the renal at a right angle and also because the left has no valves, the left ovary is more commonly diseased than is the right. The **nerves** that control the size of the ovarian vessels, pass from the spinal cord over the lesser and least splanchnics, the white rami connecting them with the anterior division of the lower three or four thoracic nerves, and reach the ovary by way of the renal, aortic and ovarian plexuses. Consequently lesions in this region will affect the vaso-motor innervation of the ovaries.

The **nerves** of the ovary are derived from the inferior hypogastric

*Williams' Obstetrics, p. 58.

plexus, by way of the uterine, and from the ovarian, which is formed from the renal and aortic plexuses. The nerves supplying the iliac fossæ, the tenth and eleventh intercostal, connect with the above plexuses; in fact, the source of nearly all the nerve force for all the above named nerves and plexuses that supply the ovary, is in the tenth and eleventh segments of the spinal cord. In most all ovarian affections, especially congestion and inflammation, the pain is felt is the abdominal wall in the area corresponding to the distribution of the tenth and eleventh intercostal nerves, which is that part of the iliac fossa on a level with the anterior superior spines of the ilia. The source of the nerve supply to the ovary furnishes an explanation of lower thoracic lesions affecting the ovary, which has been demonstrated beyond a reasonable doubt.

The **lesions** that affect the function of the ovary are most frequently found in the lower thoracic region, the ninth, tenth and eleventh thoracic vertebræ and the corresponding ribs. The reason that such lesions affect the ovary is that they lessen the size of the intervertebral foramina, and consequently the connection existing between the spinal cord and the ovary, is broken. Such lesions also produce contracture of the muscles in relation and this interferes with the function of the nerves and blood-vessels in relation which supply the ovary. Disease of the kidney is often associated with ovarian affections, especially the contracted or non-developed kidney.

THE TESTES.

The **testes,** the homologues of the ovaries, lie in a pouch called the scrotum. They are suspended and largely supported by, the spermatic cords. The testicle is somewhat larger than the ovary but in other repects resembles it. In the process of development, the testicle descends and consequently its vessels and nerves are elongated. It is covered by a reflection of a portion of the peritoneum which is carried down with it in its descent from the abdominal cavity. The connection between this cavity and the peritoneal cavity is usually obliterated but in some cases remains, this resulting in the congenital form of **hydrocele.** The acquired form of hydrocele is the result of accumulation of a serous fluid in this cavity formed by the tunica vaginalis and most commonly is the result of an injury to the covering.

The **arteries** supplying the testes are derived from the abdominal

aorta and are quite long. Their innervation is the same as that of the ovarian vessels that is, it is derived from the lower thoracic spinal segments, and the impulses reach the testicle by way of the spermatic plexus of nerves. The **veins** empty into the renal on the left, and the inferior vena cava on the right. Stagnation of the blood in them occurs often and is made worse by the long distance from their origin to where they empty, the absence of valves in them and the upright posture. This is particularly true of the veins of the left side on account of the angle formed by the spermatic and renal, it being a right angle. Stagnation of the blood in the spermatic and pampiniform plexuses of veins produces varicosities that are called varicocele. Lesions along the lumbar spine affect the innervation of these veins and thus predispose to varicocele. The lifting of heavy weights, occupations that involve standing on the feet for many consecutive hours, and abuses of the sexual function are common and important causes of varicosities of these veins. The most important of all exciting causes is ungratified sexual desire or repeated sexual excitement. Relaxation of the cremaster muscle permitting of descent of the testicle, assists in the formation of varicocele. Lesions of the upper lumbar region that affect the genito-crural nerve, produce weakening of this muscle.

The **nerves** supplying the testes are analogous to those supplying the ovaries. Lesions in the lower thoracic region affect the innervation of the testes because the impulses pass from the spinal cord at that place. This accounts for atrophy, congestion, tenderness and in fact nearly all affections of the testicle not directly traceable to trauma, excesses and infection. Head gives in his chart the sensory innervation of the testes including the epididymis, as coming from the tenth, eleventh and twelfth thoracic and first lumbar spinal nerves. This applied clinically means that painful affections of the testes can be temporarily relieved by inhibition at these points and also that lesions of these vertebræ will affect the sensory innervation of the testes and thus cause disorders of sensation. The testicle like the ovary, is supposed to have an internal secretion. Brown-Sequard observed that extracts of the fresh testes when injected under the skin or into the blood, may have a remarkable influence on the nervous system. The general mental and physical vigor and especially the activity of the centers, are greatly improved not only in cases of general prostration and neurasthenia, but also in the case of the aged. The same observer admits that some of this same substance

is found in the external secretion that is, the spermatic fluid. This accounts for the effects on the individual if there is masturbation or excessive venery. This is particularly true of the young, this indicating that this secretion has to do with the growth and development of the organism.

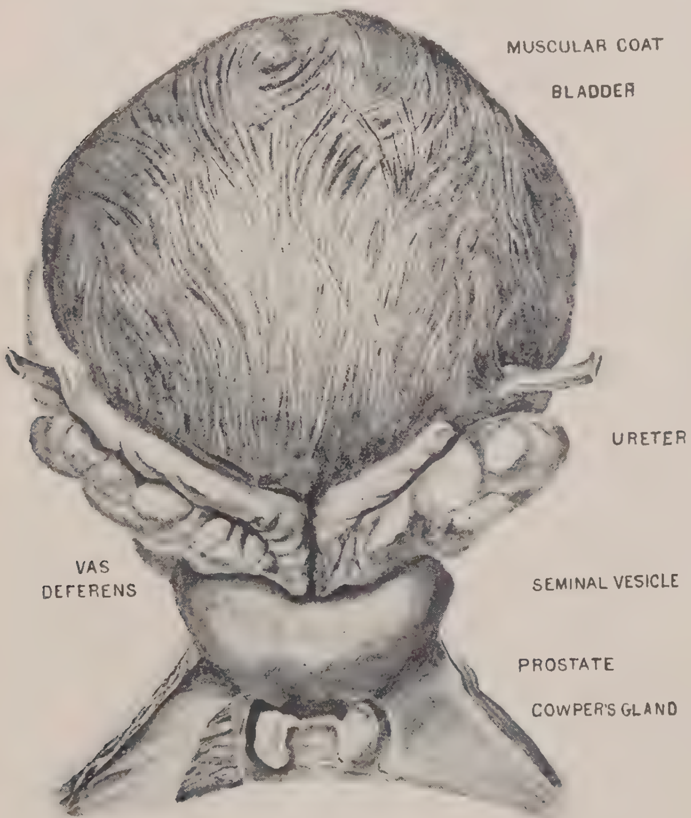

FIG. 161.—The prostate gland, seminal vesicles, bladder, vas deferens, ureter and Cowper's gland. Note the relation of the prostate and seminal vesicles to the bladder. The rectum is in posterior relation. (After Spalteholz.)

During early fetal life the testicle lies in the abdominal cavity in relation with the posterior abdominal wall and the kidney. By the seventh month, it has reached the internal abdominal ring carrying with

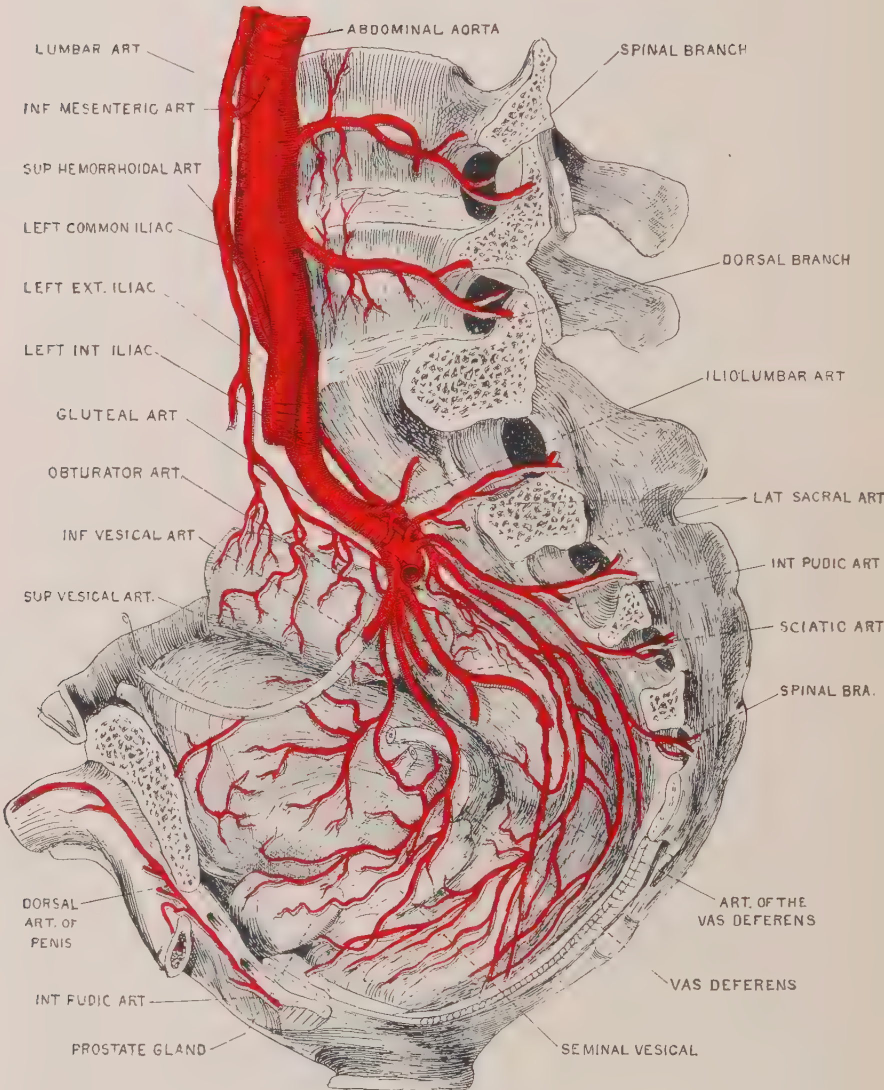

FIG. 162.—The arteries of the male pelvic organs.

it its vessels and nerves and a portion of the peritoneum. This peritoneal sac grows downward and passes through the ring carrying the testicle with it. In some cases there is failure of descent and the testicle remains in the abdominal cavity or in the groin. The writer saw a case

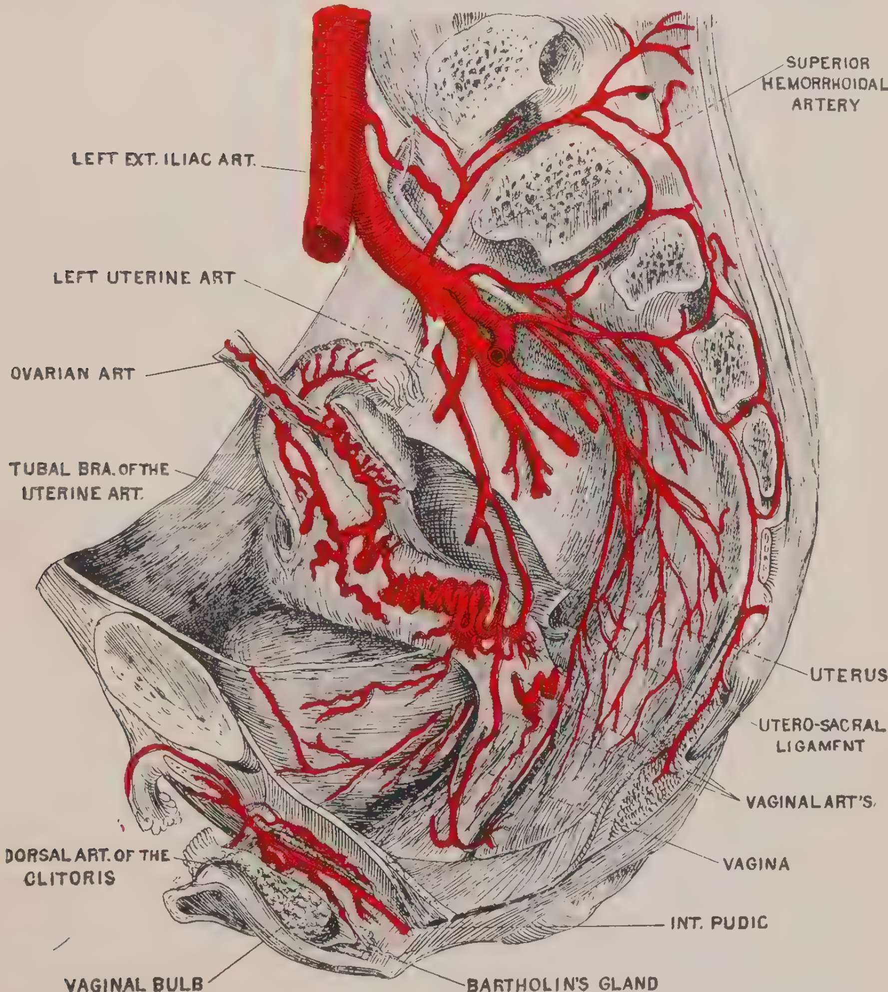

FIG. 163.—The arteries of the female pelvic organs. Note the tortuous course of the uterine and ovarian arteries.

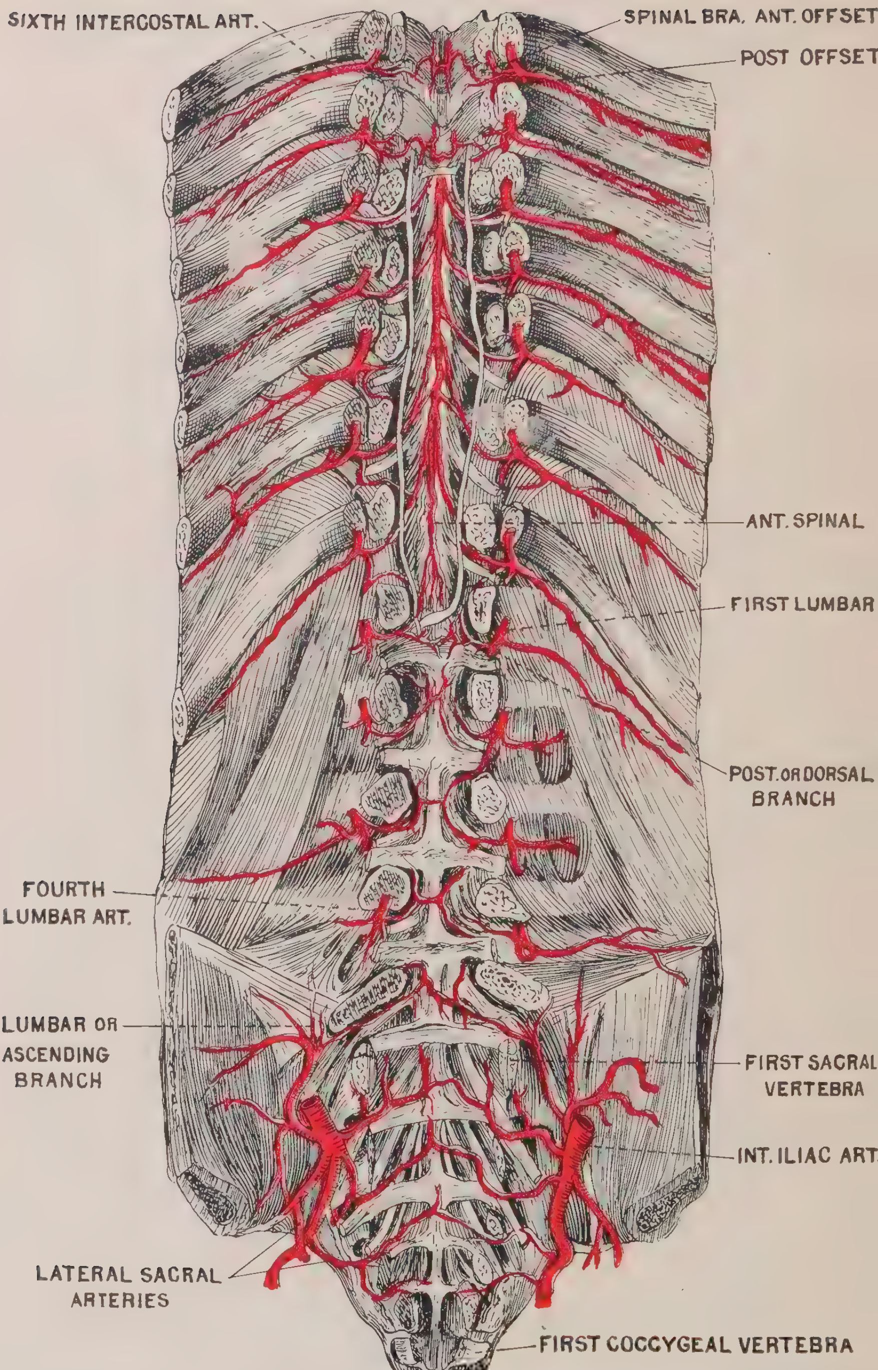

FIG. 164.—A view of the blood-vessels of the spinal cord and canal. The arches of the vertebræ have been removed.

of incomplete descent in which the right testicle had remained in the inguinal canal and had given rise to an error in diagnosis, it being treated as a case of inguinal hernia.

THE SPERMATIC CORD.

The **spermatic cord** passes through the inguinal canal and can be plainly palpated as a hard, round cord. When tender on mild pressure,

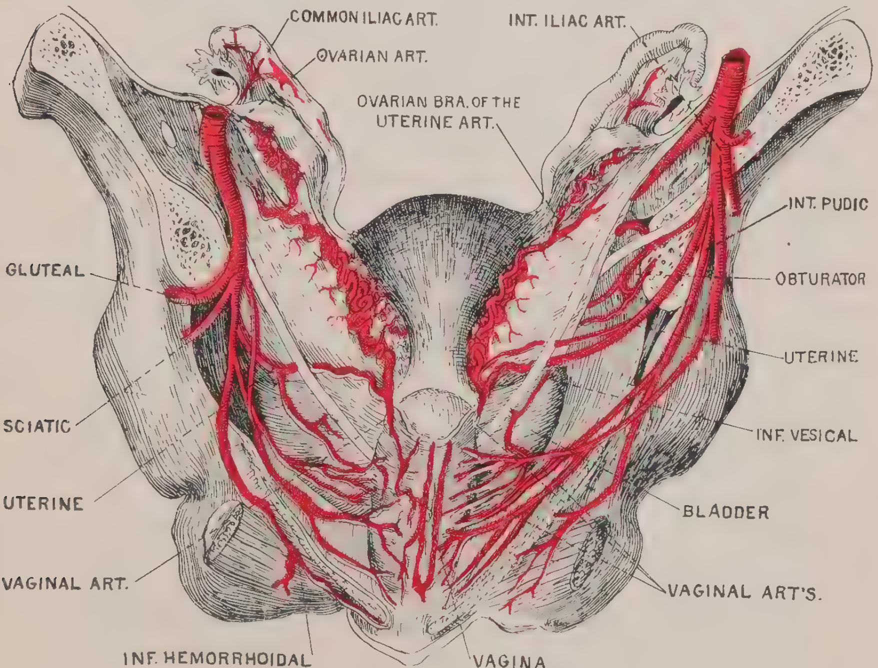

FIG. 165.—Posterior view of the arteries of the female pelvic organs.

it is indicative of congestion of its blood-vessels. This results from excessive venery and from lesions that affect the muscles of the lower part of the abdomen and the innervation of the vessels. If the muscles of the abdomen are sprained, tenderness of the spermatic cord often follows. Sprains of the hips such as would result from jumping or forced and marked abduction, will usually cause enlargement of the inguinal glands and tenderness of the spermatic cord.

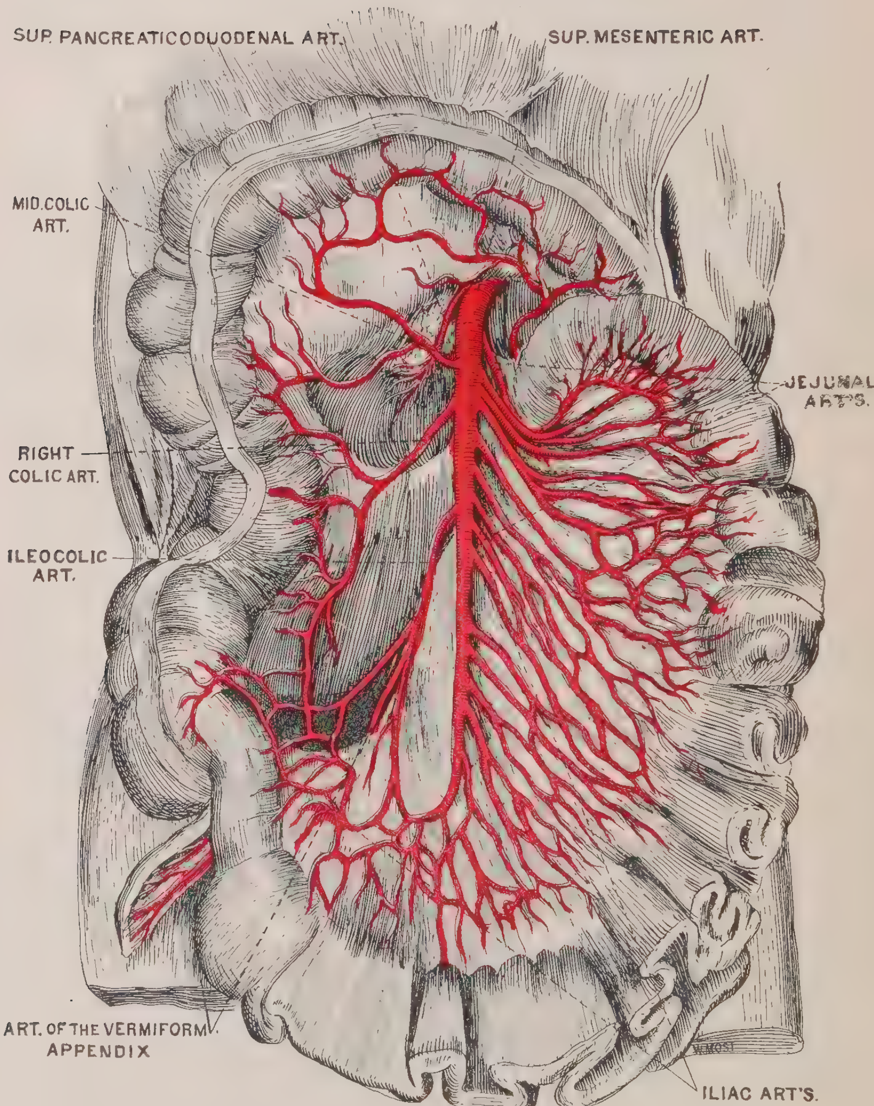

FIG. 166.—Showing the arteries of the intestines. Displacement of the bowel as in enteroptosis, materially disturbs these vessels.

THE VESICLE SEMINALES.

The **vesicle seminales** are attached to the posterior and lower part of the bladder and are thus subjected to pressure in constipation and distension of the lower bowel with hard fecal matter. Lesions of the lumbar region affect the irritability of these vessels and evacuation of their contents takes place on the least provocation. The **vasa deferentia** carry the testicular secretion from the testes to the seminal vesicles into which they empty at the lowest part.

THE PROSTATE GLAND.

The **prostate gland** is a firm musculo-glandular body situated at the neck of the bladder, and surrounds the prostatic portion of the urethra. Some claim that it is composed almost entirely of muscle fibers with few glandular elements. It is in relation with the bladder, triangular ligament, prostatic vessels, the levator ani muscle which is called the levator of the prostate, and the rectum.

The relation of the rectum is the most important on account of the frequency of constipation and its effect on the prostate. Straining at stool in case in which the bowel is engorged, results in pressure of the fecal contents on the prostate accompanied by a mucus discharge from the penis often mistaken for spermatorrhea, but in reality prostatorrhea. The gland is surrounded by a dense fibrous capsule which serves to regulate the blood pressure and the size of the gland. On account of the small amount of elasticity of the capsule, congestion and inflammation are the more painful.

The gland is divided by an antero-posterior median furrow, into two **lobes,** while some describe as a third lobe, the bulging of the front part between the neck of the bladder and the lateral lobes. This lobe is especially prominent in old people. The enlargement of the third lobe affects the urethra more than does that of the lateral, on account of its relation to the prostatic urethra. In the introduction of a catheter in patients suffering with prostatic hypertrophy, it is advisable to guide the instrument through this part of the urethra by means of the finger inserted in the rectum. On rectal examination the different lobes can be clearly outlined especially if there is any enlargement of them.

The **function** of the prostate is that of secreting a viscid, opalescent fluid that serves to form a part of, and thin the semen. "It contributes

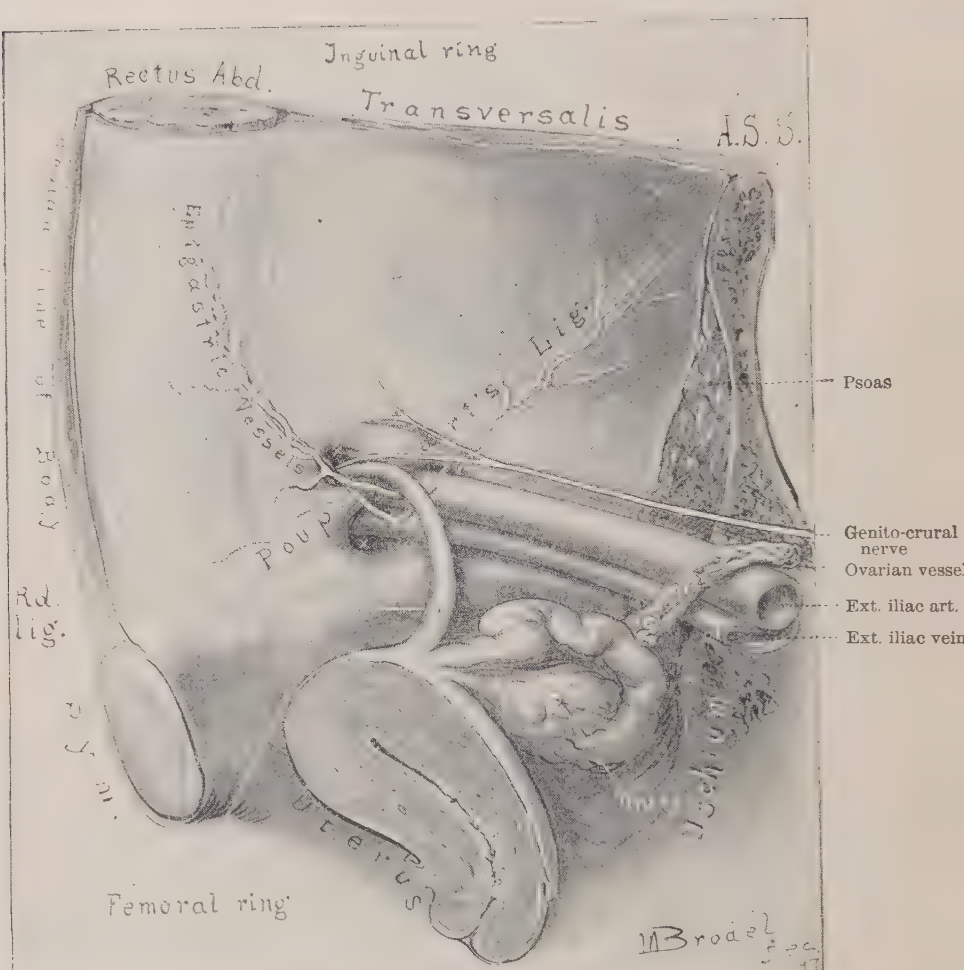

FIG. 167.—Showing the internal inguinal and femoral rings and the round ligament as viewed from within the body. (Kelly).

FIG. 168.—A view of the important vascular trunks of the uterus. (Kelly).

the substance of Charcot's crystals to the semen, and their partial decomposition is said to be responsible for the characteristic odor of the seminal fluid." (Howell). It is a **genital** rather than a urinary organ. Its principal function is that of contraction on the semen at orgasm, by which it is forcibly expelled. By contraction at the completion of the act of micturition the remaining drops of urine are expelled. In the aged, this power is often lost and the urine dribbles from the urethra for some

FIG. 169.—The normal position of the uterus viewed from the left side.

time after urinating. It seems also to be the seat of voluptuous sensation. "The seat of the venereal orgasm is in the nerves of the mucous membrane lining the prostatis sinus, as proved by the fact that it is sometimes excited by the passage of a sound through the prostate, and is not destroyed by amputation of the glans penis."*

*Keyes' Genito-urinary dis. p. 169.

The **arteries** that supply the prostate are derived from the middle hemorrhoidal, internal pudic and the inferior vesical. The innervation of these arteries comes from the plexus that surrounds the anterior division of the internal iliac which is a prolongation downward of the aortic plexus and is called by Spalteholz, the iliac plexus. This plexus like the rest, is reinforced by branches from the gangliated cord that are, in

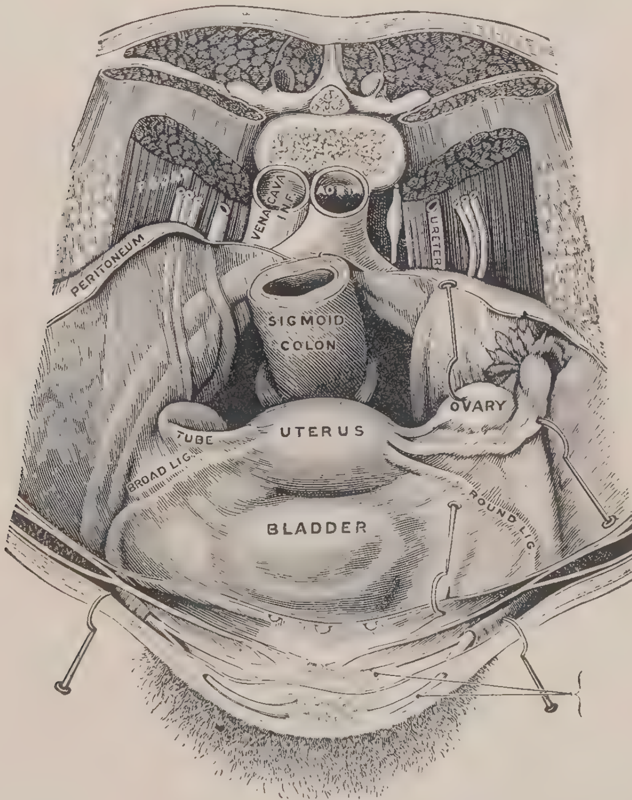

FIG. 170.—The pelvic viscera of a woman seen from above. The left ovary and tube have been drawn up into the left iliac fossa. (Testut).

this case, derived from the lumbar spinal cord and pass to, and on through without much alteration, the lumbar gangliated cord. Lesions in the lumbar region tend to interfere with this connection and consequently

are important factors in the production of diseases of viscera innervated by this part of the spinal cord, the prostate gland amongst other organs being affected.

The **innervation** of the prostate comes from the prostatic plexus, a subdivision of the pelvic plexus. Since the pelvic is made up of branches from the sacral and from the hypogastric plexus, the prostatic plexus derives its impulses from the sacral and lumbar nerves. Those from the lumbar are the more important from a practical point of view in that they are affected more frequently by lesions than are the sacral.

FIG. 171.—Sagittal section through adult woman. (Kelly).

The **veins** that drain the prostate are in free communication with those that drain the other pelvic structures and organs. This free connection between the pelvic organs permits of a congestion of one, disturbing the circulation of others.

The principal **disorders** of the prostate are hypertrophy and inflammation. These conditions may in part be due to lesions of the spinal column which act as predisposing causes, but sexual excesses and gonor-

rheal infection are the exciting causes. Such affections interfere with micturition and urination, and with the expulsion of the semen at orgasm. There is frequent micturition and painful and incomplete urination and imperfect ejaculation. If the hypertrophy is very great, it may so obstruct the prostatic urethra that retention of urine with uremia results, this resulting fatally if it continues for even a short while.

THE UTERUS.

The **uterus** which is the homologue of the prostate gland, is a pear-shaped body situated in the true pelvis with the larger end or fundus directed anteriorly when the patient assumes the erect posture. It is divided into the **fundus** which comprises that part above the Fallopian tubes, a **body** or corpus and a **neck** or cervix. It varies more in size than any other organ, even in the same individual. In the average multiparous subject, it is about three and one-half inches in length and two inches in breadth at the widest place. These dimensions are a fourth larger than those for a nulliparous subject. In the young and in those that have an infantile uterus, the cervix forms the largest part of the uterus, it comprising more than one-half. The **cervix** is the lower rounded part that projects into the vagina, at least the greater part of it does. It is of importance in that by its condition and position, many disorders of the body and fundus of the uterus that are not visible and scarcely palpable, can be diagnosed.

The walls of the body are formed of three layers of **muscle fibers;** a **serous** or peritoneal coat; and a **mucous** layer. The arrangement of the muscle fibers is peculiar, there being a circular, longitudinal and an oblique layer. By contraction of the circular, the ora are lessened in size and consequently this layer acts as a protection against the expulsion of the uterine contents as in pregnancy. The contraction of the longitudinal, acts as an expellant force, and is the important one in menstruation and parturition. By contraction of the oblique layer, the blood-vessels are temporarily ligated and is nature's method of preventing or stopping a uterine hemorrhage. This layer is especially developed at a time when its function is most needed, viz., during pregnancy and parturition.

The **ligaments** of the uterus are formed principally from the peritoneum in relation and serve to anchor and support the uterus. The **broad,** prevent lateral and downward displacement of the uterus and

act as a carrier of the blood-and lymph-vessels, and the nerves, gives attachment to the ovary, and contains the tubes, and round ligaments. The **round** ligaments prevent retro-displacement if they are in a normal condition. They are artificially shortened in Alexander's operation. The **utero-sacral,** are the most important of the uterine ligaments so far as the support of the uterus is concerned. Its fibers are almost in a vertical position when the body is in the erect posture and when relaxation of them takes place, the uterus descends into a position of retroversion and prolapsus.

The **blood-supply** of the uterus is derived from the uterine and ovarian arteries, branches respectively of the anterior division of the internal iliac and the abdominal aorta. They pass downward to the edge of the broad ligaments and thence between the two layers of this ligament into the uterus. The **vaso-motor** nerves that supply the uterine artery are derived from the lumbar spinal cord, the impulses passing from it into the gangliated cord, thence over the branches that go to form the hypogastric plexus. The vaso-motor nerves of the ovarian artery come from a point higher in the cord, viz., the ninth to the twelfth thoracic segments. The impulses pass by way of the splanchnics, renal and ovarian plexuses. Lesions affecting that part of the spinal column from which these nerves emerge that supply the uterus, affect the function of the uterus. The important lesions are in the lumbar vertebral articulations and in the innominata. The reason that such lesions affect the vaso-motor nerves that supply the uterus is that the nerve impulses come from the spinal cord and pass out from the spinal canal through the intervertebral foramina which are lessened in size by the subluxation of the vertebræ. The **arteries** of the uterus **anastomose freely** and are very tortuous thus permitting of movement and enlargement of the organ.

The **veins** form into plexuses around the arteries and most of the blood passes into and through the **pampiniform plexus** of veins located in the broad ligament. The veins are large and traverse the uterus in every direction. Although in every organ the capacity of the veins is greater than that of the arteries, the disproportion between their size and capacity in the uterus, is especially of interest. Mayrhofer says: "When the vessels of the uterus are injected, the veins and arteries with different colored injection, one is struck by the great preponderance of veins over arteries."

The circulation of the blood through the uterus is influenced by many things. Respiration when normal, assists in the circulation of the blood through the uterus. If the breathing is shallow, spasmodic or irregular, the blood tends to become stagnant in the uterus as well as in other organs of the body. Deep breathing is of great value in the treatment of disorders of the uterus because it assists in the establishment of a normal circulation through the uterus, a thing absolutely necessary if the disorder is to be cured. The contraction of the muscles of the abdomen and back, the heart beat, the condition of the vaso-motor nerves, and of the vessels themselves, the condition of the uterus that is, its tone

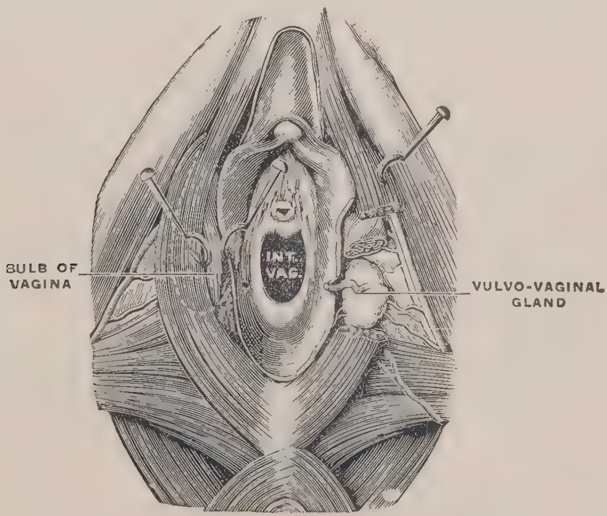

FIG. 172.—The vulvo-vaginal gland or gland of Bartholin. The dotted line indicates the limits of the bulbs of the vagina. (Testut).

and size, the position of the organ and the posture of the patient all are to be considered as important factors in the circulation of the blood through the uterus. If the muscles are poorly developed or atrophied, if the heart is weak, the vaso-motor impulses lessened in amount and number, the vessels diseased, the uterus relaxed and out of normal position, or if the patient keeps the erect posture too long, the circulation of the blood through the uterus will be impaired.

The **lymphatic** vessels of the uterus empty into the hypogastric and lumbar glands, those from the lower part emptying into the hypogastric.

This is of importance in the explanation of certain abdominal tenderness since the tenderness is often due to **enlargement of these lymph glands** from an inflammation or **injury** of the **uterus.** Care should be exercised in the abdominal treatment of such cases since the glands, enlarged and tender, may be injured by injudicious manipulation of them.

The **nerve** supply of the uterus is derived from the cerebro-spinal and sympathetic systems. The lower part is supplied mostly by the anterior division of the second, third and fourth sacral nerves, the fibers passing through the pelvic plexus into the uterine. The sympathetic nerves are derived from the uterine and ovarian plexuses and are primarily derived from the lower thoracic and lumbar segments of the spinal cord. Langley states that in experiments on animals it has not been demonstrated that any impulses from the sacral nerves reach the uterus at all, that is, stimulation of these nerves produces no apparent effect on the uterus. Starling says: "The internal organs, i. e., the uterus and vagina in the female and vasa deferentia, seminal vesicles, and uterus masculinus in the male, differ from the external organs in receiving no efferent nerve fibers from the sacral nerves, as has been pointed out by Langley and Anderson. They are supplied with fibers which pass out through the anterior roots of the third, fourth and fifth lumbar nerves (in the rabbit and cat), and run through the sympathetic to the inferior mesenteric ganglia, whence they proceed by the hypogastric nerves. On stimulating these fibers, two effects are produced on the uterus and vagina, namely, a contraction of the small arteries, leading to pallor of the organs and a strong contraction of the muscular coats."* This in the main, coincides with the experiments and observations in the human and helps to substantiate the claim that lesions in the lumbar region affect the function of the internal generative organs. Stimulation over the posterior divisions of the sacral nerves will undobtedly cause contraction of the uterus, this having been demonstrated by the writer in hundred of cases, especially during parturition. This would indicate that the sacral nerves supply the uterus with motor and perhaps other impulses.

"According to most authorities there is a center for uterine movement situated in the lumbar region of the spinal cord. The fibers from this center emerge by the third, fourth, and fifth, lumbar nerves and possibly from some sacral nerves and communicate with the pelvic

*Schafer's Physiology, Vol. II, p. 349.

plexuses of the sympathetic. Many of the nerve fibers are destined for the supply of the blood-vessels, but without doubt some control the uterine contractions, for if the lumbar center be destroyed all power of parturition is abolished. Stimulation of the nerves, moreover, produces powerful uterine and vaginal contractions."

Clinically, it is well known that lesions of the lumbar articulations produce uterine disorder, this being the result, as stated before, of disturbance of the innervation, it being, according to the above citation, from the lumbar spinal nerves.

The **function** of the uterus is that of menstruation and parturition. These functions are controlled by centers located in the lumbar spinal cord. The character and amount of blood that passes through the uterus

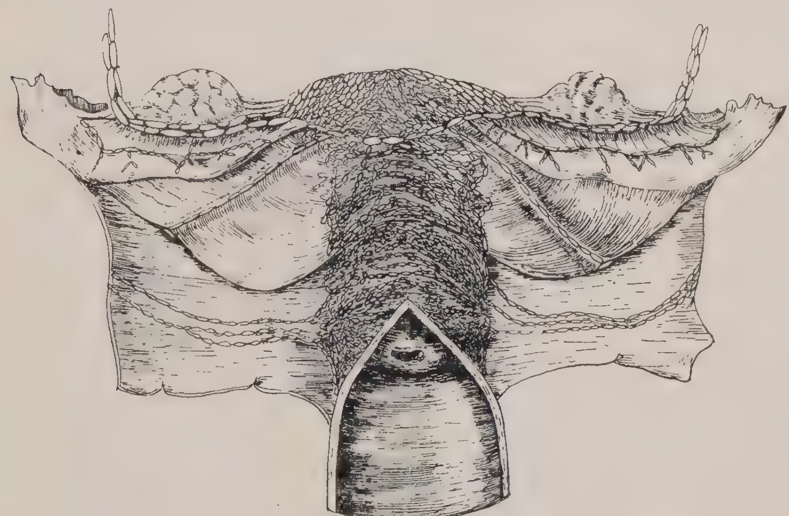

Fig. 173.—The lymphatic vessels of the vagina and uterus

are the most important of all factors that have to do with its function. Lesions of the innominata, sacrum, lumbar and lower thoracic vertebræ affect the function of the uterus, that is, make menstruation abnormal or interfere with pregnancy and parturition. They do this by affecting the blood supply, the nerve supply, the spinal center and by affecting the nutrition of the uterus. These lesions are characterized by irregu-

*Manual of Midwifery, p. 50, 906. Jellett.

larity and tenderness over and around the articulation, and in the case of the vertebræ, over the spinous processes.

THE EXTERNAL GENITALIA.

The **external genitalia** are subject to disturbances from spinal and other lesions. The vaso-motor centers controlling their blood-supply are located in the lumbar spinal cord and any lesion that breaks the connection between them and the parts supplied, will cause disturbance or disease in the parts. The sacral nerves seem to be motor but partly vaso-motor to the external genitalia. Starling says: "The external generative organs like the bladder, are supplied from two sets of nerve fibers—from the lumbar nerves through the sympathetic, and from the sacral nerves. The fibers from the lumbar nerves arise in the cat from the second, third, and fourth, or the third, fourth and fifth lumbar nerve roots, and in the dog from the thirteenth thoracic and the first to the fourth lumbar roots. They run in the white rami communicantes to the sympathetic chain, whence they may take two paths.

(a) The great majority of the fibers run down the sympathetic chain to the sacral ganglia, whence fibers are given off in the grey rami communicantes to the sacral nerves; their further course is by the pudic nerves, none running in the nervi erigentes.

(b) A few fibers go by the hypogastric nerves to the pelvic plexus. Excitation of these fibers causes strong contraction of the arteries of the penis, and of the unstriated muscles of the tunica dartos of the scrotum."* These nerves are vaso-motor, secretory, motor, sensory and trophic and consequently any form of disorder of the external genitalia may be produced by or predisposed to, by lesions that affect these nerves. These lesions are similar in character and location, to those that affect the internal generative organs.

THE MAMMÆ.

The **mammary gland** in the female, consists of an aggregation of compound racemose glands, the ducts of which open separately at the nipple. In the male, the gland is rudimentary and the nipple marks the location of the fourth rib. In the female they extend from the third to the sixth or seventh ribs and are enveloped with the superficial fascia which seems to split to receive them. They vary in shape and size in

*Schafer's Physiology, p. 348, Vol. II.

different individuals, and in the same person at different times. They are not exactly symmetrical, the left is usually the larger and they are pendulous in the average case and especially so in multiparæ. In structure they are regarded as modified sebaceous glands and consequently appendages of the skin.

The **arteries** are derived from the long thoracic, the external mammary and from the intercostals in relation and from the internal mammary.

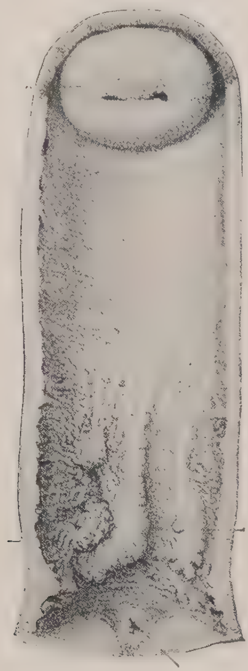

Fig. 174.—Anterior wall of vagina, showing columnæ (Savage.) 1, 2, anterior columns of the vagina; n, urethral orifice; m, cervix.

The branches of the internal mammary perforate the intercostal spaces, the second, third, fourth and sometimes the fifth, and are thus subject to pressure from subluxations of the corresponding ribs. The innervation of these arteries is from the lower cervical but particularly from the upper thoracic region. Lesions in this region, especially affect the function of the breast.

The **veins** correspond to the arteries and empty into corresponding trunks. The superficial veins become markedly engorged in enlargement of the breast as during pregnancy. On account of the relation of these veins to the ribs and the clavicles, displacement of these bones will obstruct to a greater or lesser degree the passing of the blood from the gland to the heart and thus cause disorder of function of the breast.

The **nerves** are exceedingly numerous and important. McLachlin says: "We have (1) twigs from the fourth and fifth cervical nerves; (2) twigs from the anterior cutaneous branches of the second, third,

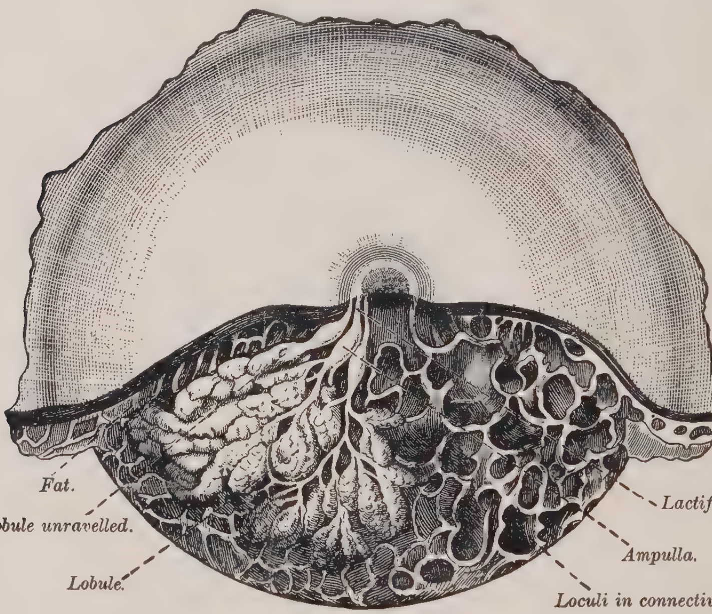

FIG. 175.—Dissection of the lower half of the female breast during the period of lactation. (Luscka).

fourth and fifth intercostal nerves, and of the lateral cutaneous of the third, fourth and fifth. Now, from the second, is given off the intercosto-humeral, supplying the skin of the inside of the arm and axilla; from the third a branch to the same parts, and also the skin about the shoulder; and from the fourth and fifth, the skin near the scapula. These communications explain the widely diffused pain in cases of inflammatory

affections, especially of the breast."* Lesions of the ribs in relation with the nerves innervating the mammary glands are common and important causes of affections of the breast.

It is claimed by some, that there are no secretory nerves to the breast that is, section of all the mammary nerves does not lessen the secretion of milk. This has been doubted by others and clinically it seems that the secretion of milk is controlled to a great extent by the nerves, especially the vaso-motor nerves.

The **acini** and ducts of the gland are surrounded by a net-work of lymph vessels. The axillary glands drain most of the lymph vessels of the breast. This is well demonstrated about the time of the establishment of lactation after parturition. At this time the axillary glands become very much swollen and tender, making movements of the arm painful.

The appearance and condition of the breast furnish indications of certain disorders that are fairly reliable. If the nipple is short and retracted it is suggestive of ovarian affection on the same side or the schirrous form of carcinoma. A pendulous breast indicates multiparity. A large mammary gland may be the result of deposit of fat or of irritation of the sexual organs. If at or near puberty, it is suggestive of premature development of the ovaries and a state of sexual excitement. Tenderness of the breast usually occurs at menstruation and in certain forms of uterine and ovarian disease. If localized and the tissues hard and retracted, it indicates cancer. **Pigmentation** occurs during pregnancy and in some cases of polypi of the uterus. The breasts undergo atrophy at the menopause and the glandular elements are replaced by adipose tissue if the size is retained. Many disorders of the breast result from direct trauma on account of the exposed position of the gland but most of the affections are due to lesions of the third, fourth and fifth ribs plus some exciting cause such as ovarian or uterine disorder.

*Applied Anatomy, p. 226, Vol. II.

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